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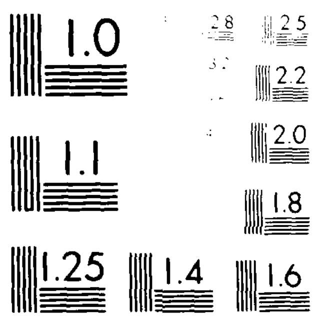
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STATEMENT OF FINDINGS
UNION LAKE
BOURBEUSE RIVER, MISSOURI

I have visited the project area and reviewed the documents relating to Union Lake, Bourbeuse River, Missouri. I have considered the comments submitted by interested parties in response to the draft environmental impact statement issued in February 1974. I have also carefully studied the complaint of the Sierra Club, et al, against water resource development in the Meramec Basin, filed in the U.S. District Court for the Eastern District of Missouri, Eastern Division, on 25 September 1972.

In my review of this project, I have found that Union Lake was originally authorized for construction by the Congress in 1938. The project was included in a subsequent review of the overall Meramec River Basin and included those projects recommended for construction in the Meramec River, Missouri Comprehensive Basin Study, Summary Report, 15 June 1965. This report stated that the short- and long-term needs of the basin were flood control; recreation; domestic, municipal and industrial water supply; water quality control; and fish and wildlife conservation. The study indicated the dominant needs in the Meramec Basin are flood control and recreation.

The plan for Union Lake, as presently formulated and authorized was coordinated with and took into consideration the programs and views of 23 Federal and State agencies. The opinions of quasi-public and private organizations were solicited and considered. Consequently, the plan for the development of Union Lake was the product of professional planning effort and a consensus of a broad spectrum of informed and affected citizens in the Meramec Basin and the St. Louis metropolitan area. In the formulation of Union Lake, the objective was to devise a sound plan for the development of water and related land resources to meet a portion of the immediate and long range needs of the basin in an orderly, efficient, and timely manner. Consideration was given to all aspects of a multi-purpose lake project on the Bourbeuse River. It was determined that the major primary project benefits were flood control, water supply, recreation, fish and wildlife and navigation. The project, when operative, will have the ability to satisfy the following needs:

Recreation

The lake will support an annual visitation of 1,878,000 general recreationists within the first three years of project life. Approximately 1,438,000 visitors will be accommodated at Corps-constructed recreation facilities and the balance on State, local government or private facilities.

Flood Control

The lake will impound storm runoff and furnish protection against a flood having a frequency of once in a period exceeding 200 years, to approximately 7,020 acres of the valley between the dam and the confluence of the Meramec and Bourbeuse Rivers. Partial protection will be afforded to an

additional 21,290 acres in the lower Meramec Valley between the mouth of the Bourbeuse River and the confluence of the Meramec and Mississippi Rivers. The lower portion of the reach has undergone extensive urban development, particularly industrialization.

Water Supply

The storage for water supply of 92,590 acre-feet in the normal pool can be released when required to meet the requirements for water supply in the lower Meramec Basin during periods of low flow. This storage will also be available for water supply withdrawal by towns above the dam near the lake. The lake will be able to supply a minimum of 71 million gallons of water per day.

Fish and Wildlife Conservation

The normal pool of Union Lake will have a surface area of 6,600 acres. The U.S. Fish and Wildlife Service has estimated in a 1964 study, that there will be a net increase of 250,700 annual fisherman-days with the project. I have been informed that the U.S. Fish and Wildlife Service is conducting a new study for the area. However, this is the best data presently available and is considered reasonable. In the upper reaches of the lake it is proposed to acquire 4,200 acres of project lands which will be used in a wildlife management program. In addition, land and water releases will be made available, upon request, to a State or Federal agency for the establishment and operation of a fish hatchery downstream of the lake.

Navigation

During low flow periods, releases for water supply and low flow augmentation in the Bourbeuse and lower Meramec Rivers will incidentally benefit navigation on the Mississippi River.

Area Development

The construction of Union Lake will provide increased work opportunities to the people of the project area. Tourism and recreational industries, resulting from the project, are expected to increase the level and tempo of the local economy.

I have noted and carefully considered the adverse environmental impacts which will result from the Union Lake project. Approximately 36 miles of the Bourbeuse River, three caves and one natural spring will be permanently inundated. In addition, approximately 6,600 acres of highly productive wildlife habitat, including the habitat for several rare species of mollusks, amphibians, birds and mammals will be covered permanently by water, including the nationally endangered Indiana bat, *Myotis sodalis*, which is protected by the Endangered Species Act of 1973 (P.L. 93-204). All actions necessary to meet the requirements of this Act will be incorporated in planning and construction procedures.

Almost 2,200 acres of agricultural land will be inundated, and an additional 6,400 acres will be incorporated into other project purposes, such as recreation and administrative areas. At full flood control pool (estimated at once in 200 years) an additional two caves, two springs and 23 miles of streams and 6,300 acres of wildlife habitat will be flooded. Approximately 100 families who reside in the project area will be relocated. Thirty known archeological sites will be inundated by the normal pool. In response to comments received, the St. Louis District contracted with a professional archeologist to evaluate the adequacy of the current archeological knowledge in the project area. His report indicates that more information is needed. I am requesting that funds be made available under Public Law 93-291 to perform additional surveys and any explorations subsequently deemed appropriate. The period required for construction of the project provides ample time for archeological survey and salvage operations that are required.

I have concluded that the historical survey intitially conducted was inadequate with regards to the requirements of Executive Order 11593. To remedy this situation, a comprehensive survey of historical resources of the Union Lake project area has been conducted by a professional historian and included in this final environmental impact statement.

Two cultural resources, Noser's Mill, an old grist mill; and the Koenig Shelter, a Late Woodland archeological site will be inundated. Both of these resources may be of National Register significance. The St. Louis District, in consultation with the Advisory Council on Historic Preservation, will follow the Advisory Council's guidelines, as required by Executive Order 11593, to determine appropriate protective or mitigative measures for all specially designated sites.

I also recognize the potential danger to ground and surface water quality if necessary land-use regulations are not imposed on non-Federal lands surrounding the project. However, this deterioration of water quality will probably occur due to population pressures if the project is not constructed. Additional detrimental impacts that may occur as a result of development pressures generated by the project could include a change in the rural atmospheres of the area, increased traffic and noise, a much greater demand on public facilities and services as well as losses to wildlife habitat. Due to the westward expansion of the St. Louis metropolitan area, these impacts will probably take place over time with or without the construction of Union Lake. Further, these impacts may be more adverse without the planned land and water resource management actions associated with the Union Lake project. Other impacts of less significance are recognized in the environmental impact statement.

I believe that all appropriate steps were taken in the preparation and presentation of the environmental impact statement to disclose fully all known environmental issues. All pertinent facts have been presented and discussed by appropriate professional personnel on my staff. I believe the environmental impact statement complies with the National Environmental Policy Act of 1969 in letter and spirit.

The possible consequences of various practicable and reasonable alternatives have been studied with regard to environmental, social well-being and economic effects including regional and national development and engineering feasibility. Included are alternatives designed especially to minimize the recognized adverse environmental impacts which will result from the Union Lake project. As a part of the decision making process, a concerned effort was made to identify the relative merits of each alternative. Other factors bearing on my analysis have been the expressed opinions and concerns of several local and regional planning organizations. The alternatives studied included abandonment of the project, alternate main stem reservoirs, headwater and tributary reservoirs, dry lakes, preservation of the Bourbeuse River for recreational or scientific purposes, various proposals for the creation of National Recreation Areas, flood plain zoning, levee protection, and various combinations of these alternatives. Each of these alternatives is discussed in the Union Lake Environmental Impact Statement.

I find that the needs of the Meramec Basin for flood control, recreation, and water supply are compelling. The significant benefits of the Union Lake Project clearly outweigh, in my opinion, the recognized adverse environmental impacts attendant to the project.

Therefore, being fully apprised of the environmental, social, and economic losses and gains which will accrue from the project, and having considered all practicable alternatives in the light of economic and environmental factors, social well-being, and engineering feasibility, I have concluded that, on balance, the net effects of the Union Lake are beneficial, and that it is in the best interest to complete the project.

8 April 1975
Date

Thorwald Peterson
THORWALD R. PETERSON
Colonel, CE
District Engineer

I concur in the preceding Statement of Findings.

F P Koisch
F. P. KOISCH
Major General, USA
Division Engineer

28 April 75
(Date)

I concur in the preceding Statement of Findings.

21 May 1975
(DATE)

J. W. MORRIS
Major General, USA
Director of Civil Works

SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. A[illegible] A[illegible]	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (*and Subtitle*) Union Lake Bourbeuse River, Missouri Final Environmental Impact Statement		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Engineer District, St. Louis 210 Tucker Blvd. North St. Louis, MO 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE October 1974 13. NUMBER OF PAGES 346
14. MONITORING AGENCY NAME & ADDRESS (*if different from Controlling Office*) US Army Engineer District, St. Louis 210 Tucker Blvd., North St. Louis, MO 63101		15. SECURITY CLASS. (*of this report*) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (*of this Report*)

Distribution unlimited.

17. DISTRIBUTION STATEMENT (*of the abstract entered in Block 20, if different from Report*)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (*Continue on reverse side if necessary and identify by block number*)

20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

Union Lake will be located in Franklin Coutny, Missouri. The impoundment will be formed by the construction of a dam on the Bourbeuse River at river mile 32.5 above the confluence of the Meramec and Bourbeuse Rivers. The purposes of the lake are recreation, flood control, water quality, water supply, fish and wildlife, navigation and area development. The lake will have a normal pool of 6,600 acres and a maximum flood control pool of 12,900 acres.

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SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

FINAL

ENVIRONMENTAL STATEMENT

UNION LAKE

BOURBEUSE RIVER, MISSOURI

Prepared by:

U. S. Army Engineer District
St. Louis, Missouri

October 1974

SUMMARY SHEET

Union Lake, Bourbeuse River, Missouri

( ) Draft (X) Final Environmental Statement

Responsible Office: U. S. Army Engineer District, St. Louis, Missouri

1. Name of Action: (x) Administrative ( ) Legislative

2. Description of the Action: The Union Lake will be located in Franklin County, Missouri. The impoundment will be formed by the construction of a dam on the Bourbeuse River at river mile 32.5 above the confluence of the Meramec and Bourbeuse Rivers. The purposes of the lake are recreation, flood control, water quality, water supply, fish and wildlife, navigation and area redevelopment. The lake will have a normal pool of 6,600 acres, and a maximum flood control pool of 12,900 acres.

3. a. Environmental Impacts: Inundation of wildlife habitat, conversion of stream habitat to lake habitat; flood protection to urban and rural areas; elimination of stream recreation on the 59 miles of the Bourbeuse River and its tributaries inundated by the lake; increase the opportunity for recreation on the 32 miles of the Bourbeuse River below the dam and 60 miles on the Meramec River between the confluence of the Bourbeuse and Meramec Rivers and the Mississippi River; provision of increased public recreation on the stream area converted to lake through improved access, changes in land use, and landscape diversity; inundation of archeological sites; relocation of cemeteries, roads and utilities; temporary impacts during construcion; higher ground water levels; potential for ground water pollution; provision of water supply storage to meet future requirements in the lower Meramec Basin and the towns near the lake; immediate economic effect on local area; long-term economic effect on the region; alteration of tax structures; relocation of 100 families; alteration of social relationships; change in vegetation; increased area under wildlife management; improvement of navigation on the Mississippi River during low-flow periods by the release of water for water supply, and improved downstream fisheries.

b. Adverse Environmental Effects: Loss of terrestrial wildlife habitat and reduction of animal and plant numbers; loss of habitat for rare and endangered species; reduction of mast producing trees which provide food and cover for wildlife; reduction in miles of flowing streams and associated riparian habitat types; inundation of caves; reduced opportunity for stream-oriented recreation in inundated stream reaches; change in land use and the resultant effect on the agricultural sector of the economy; inundation of archeological sites; hardship on residents who are forced to relocate; downstream development as a result of project provided flood protection would cause increased pressure on the existing ecosystem; potential

5. Requirement that each state submit to the Administrator by 1 January 1975 a report which will include a description of the nature and extent of non-point sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the cost of implementing such programs.

Water quality benefits and storage: The statutory mandates of Public Law 92-500 indicate the pollution of navigable waters must cease by 1985. Construction of Union prior to the Federal Water Pollution Control Act Amendments of 1972 did not take place. Henceforth, no water quality benefits and storage can be claimed. This act does not preclude stream flow augmentation as a project purpose. The Corps looked into the matter of subjoining stream flow as a viable inclusion but found this not to be a supportable or practicable addendum at this time. Stream flow augmentation could be claimed for canoes and fishermen if the flows along the Meramec and Bourbeuse Rivers needed augmentation. Preliminary investigations indicated that, for canoeing purposes, a minimum of one foot of water is required. A review of a 37-year period of record indicated that Meramec River flows had not gone below 130 cfs (1.5 feet at Pacific) and only twice in recorded history has it reached this low point. Thus, there does not appear to be rationale for stream flow augmentation as a purpose. Further, the Meramec Park reservoir will stabilize flows without the Union project, suggesting that the heretofore natural flow minimum of 130 cfs will probably not be experienced again. Augmentation along the Bourbeuse River is not considered necessary for the same reasons. Therefore, the Union Lake project does not include reservoir storage for any type of flow augmentation. The present plan does include reservoir storage for recreational purposes incorporating approximately the same volume previously allocated to water quality.

pollution of ground and surface water supplies; loss of natural vegetation; stress on existing highway system.

4. Alternatives:

a. Alternatives studied before authorization of the Union Lake project.

b. Other alternatives open for consideration.

(1) Nonstructural alternatives.

(a) Abandonment of construction of Union Lake project.

(b) Preservation of the Bourbeuse River for recreational and scientific purposes.

(c) Nonstructural flood damage protection measures.

(2) Structural alternatives.

(a) Dry lake.

(b) Upstream multi-purpose lakes.

(c) Levee protection.

(3) Combination of nonstructural and structural measures.

5. Comments Received:

Thomas F. Eagleton, United States Senator
U. S. Forest Service
U. S. Soil Conservation Service
Environmental Protection Agency
Federal Power Commission
U. S. Department of Housing and Urban Development
U. S. Department of the Interior
Advisory Council on Historic Preservation
U. S. Department of Transportation
U. S. Department of Commerce
Office of Economic Opportunity
State of Missouri
Missouri State Park Board
Meramec Basin Association
Missouri Speleological Survey, Inc.
Citizens Committee to Save the Meramec, Inc.
Missouri Chapter of the American Fisheries Society
Max Allen Nickerson
Paul L. Redfearn, Jr.

ENVIRONMENTAL STATEMENT

UNION LAKE
BOURBEUSE RIVER, MISSOURI

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APPENDIX

TABLES

PART SIX - ALTERNATIVES

PART NINE - COORDINATION WITH OTHERS

PLATES

FIGURES

1. PROJECT DESCRIPTION AND HISTORY

1.1 LOCATION

The project will be located in Franklin County about 6 miles southwest of the town of Union (PLATE 1). The damsite is on the Bourbeuse River, 32.5 miles upstream from its confluence with the Meramec River. The main access route to the dam would be by county road WW from Interstate Highway I-44 (U.S. 66) (PLATE 2), the intersection being 1 mile southwest of St. Clair, Missouri. The alternate route would be county road UU from U. S. Highway 50, the intersection being 1 mile west of Union, Missouri.

1.2 AUTHORIZATION AND HISTORY OF THE PROJECT

The project was authorized by the Flood Control Act of 28 June 1938, Flood Committee Document No. 1, 75th Congress, 1st Session.

Union Lake has been recommended for start in Fiscal Year 1976. If construction funds are appropriated, land acquisition would be initiated, a contract let for abutment treatment, and engineering and design continued. On 29 December 1970, an advance participation contract was signed with the Missouri State Highway Commission. This contract provided for construction of Missouri State Highway 185 at a location and elevation which would be compatible with the Union Lake requirements. The road project is in the design and right-of-way stage. The estimated cost of relocating Highway 185, Federal and State funds is $3,000,000.

The present estimated cost of the Union Lake project (1 July 1974) including the Highway 185 relocation is $51,200,000. The sequence for initiating major construction items on the project is given in Table 1.

Table 1. Sequence for initiating major construction items.

	Sequence
State Highway 185	1st year
Preparation of Abutments	2nd year
Administration Building	3rd year
Dam and Spillway	4th year
Land Clearing	5th year
Impoundment	5th year

1.3 GENERAL DESCRIPTION AND PURPOSE

The Union Lake will be formed by the construction of a rolled, earth-filled dam which will have a crest length of about 2,100 feet and a top width of 35 feet (See PLATE 3). The maximum height of the embankment will be 150 feet above the mean streambed. The lake will extend at normal pool approximately 36 miles upstream on the main stem of the Bourbeuse River (See PLATE 2). The impoundment will have a surface area of 6,600 acres at normal pool, elevation 619.0 m.s.l., and 12,900 acres

at the top of flood control pool, elevation 651.0 m.s.l. At full flood control pool, the lake will have a capacity of 477,300 acre-feet. Other pertinent data are presented in Table 2.

In the formulation of Union Lake, the objective was to devise a sound plan for the development of water and related land resources to meet the immediate and long-range needs of the Basin in an orderly, efficient and timely manner. Consideration was given to all beneficial aspects of a multiple-purpose lake on the main stem of the Bourbeuse River. In the case of Union Lake, it was determined that the major primary project benefits were flood control, water supply, stream flow augmentation (pollution abatement), recreation, fish and wildlife conservation, and navigation. The applicable benefits and separable costs of each project purpose, based on a 100-year economic life, were determined, and the relative benefit-cost percentage was allowed to seek its own level of importance.

1.4 MAJOR STRUCTURAL FEATURES OF THE PROJECT

The following is a brief description of the principal structures required by the proposed plan of development. Investigations and preliminary designs have advanced sufficiently to assure an economical and feasible plan.

1.4.1 DAM EMBANKMENT

The dam embankment will be approximately 2,100 feet long with a crown width of 35 feet, and a maximum dam height of 155 feet above valley rock. It will consist of an impervious clay zone and an upstream pervious shell composed of two zones. Sand and gravel deposits from borrow areas in the valley will be used to construct the interior portion of the upstream pervious shell. Fresh rock from the spillway excavation will form the outer shell zone upstream. A filter zone with 5-foot horizontal dimension and slopes of 1 on 0.4 separates the pervious material from the impervious material. Core slopes of 1 on 0.4 and 1 on 0.5 have been found to be adequate for outer and inner rock slopes of 1 on 2.5 and 1 on 1.8, respectively. The impervious core will be about 13 feet wide at the top of the sand drain with a maximum width of 110 feet on rock at the base of the dam. A cut-off trench into rock is not required. An inclined pervious sand drain 10 feet in thickness will be constructed within the impervious clay zone. This inclined part of the sand drain will be controlled by a 1 on 0.5 slope line beginning 10 feet upstream of the downstream edge of the crown of the embankment and will extend from 5 feet below the top of the dam to intersect a horizontal sand drain 5 feet thick under the downstream portion of the dam. The downstream slope of the dam will be covered with a 6-inch layer of topsoil obtained from material stripped from the downstream borrow area, and seeded.

1.4.2 SPILLWAY

The spillway will be located in the left abutment ridge separating the Bourbeuse River and Voss Creek (See PLATE 3A). The spillway crest will be located in a rock cut.

Table 2. Pertinent project data.

Location of Dam		
Stream	Bourbeuse River, Missouri	
River mile, above mouth	32.5	
County	Franklin	
Location of Lake (normal pool)		
River mile, above mouth	32.5 to 68.5, approximately	
County	Franklin	
Drainage Area		
Upstream from damsite, sq. mi.	771	
Stream Flow, Under Natural Conditions (At Damsite) (Period 1921 to 1968, inclusive)		
Average daily flow	c.f.s.	617
Maximum flow	c.f.s.	33,100
Minimum flow	c.f.s.	11
Channel Capacity Below Damsite	c.f.s.	4,000

Items	Units	Initial	After 100-year sedimentation (1)
Inactive Pool			
Elevation	feet	571	571
Area	acres	1,000	800
Storage	acre-feet	13,700	9,200
Storage (runoff)	inches	0.33	0.22
Joint-Use Pool			
Elevation	feet	618.6	618.6
Area	acres	6,600	6,400
Storage	acre-feet	160,500	155,000
Water supply storage	acre-feet	10,500	10,500
Equivalent runoff	inches	0.25	0.25
Equivalent runoff	inches	0.81	0.81
Recreation	acre-feet	116,800	111,300
Maximum regulated outflow (mean daily)	c.f.s.	4,000	4,000
Minimum regulated outflow (mean daily)	c.f.s.	11	11
Flood Control Pool			
Elevation	feet	651	651
Area	acres	12,900	12,900
Storage	acre-feet	303,100	303,100
Storage (runoff)	inches	7.37	7.37
Regulated outflow (mean daily)minimum	c.f.s.	4,000	4,000

Items	Units	Initial	After 100-year sedimentation (1)
Surcharge Pool			
Elevation	feet	679.5	679.5
Area	acres	21,900	21,900
Storage	acre-feet	491,200	491,200
Storage (runoff)	inches	11.94	11.94
Maximum outflow	c.f.s.	88,200 (1)	88,200 (1)
Freeboard			
Elevation	feet	683	683
Area	acres	23,198	23,198
Storage	acre-feet	78,900	78,900
Storage (runoff)	inches	1.92	1.92
Height	feet	3.5	3.5

Items	Units	Value
Standard Project Flood		
Peak flow (natural conditions)	c.f.s.	73,400
Peak inflow (reservoir)	c.f.s.	114,300
Peak outflow (reservoir)	c.f.s.	4,000
Design storm	inches	11.57
Runoff (includes base flow)	inches	7.74
Runoff (includes base flow)	acre-feet	318,300
Spillway Design Flood		
Peak inflow	c.f.s.	264,000
Peak outflow	c.f.s.	88,200
Spillway design storm	inches	25.01
Runoff (includes base flow)	inches	19.92
Runoff (includes base flow)	acre-feet	819,100

(1) Includes 3,000 c.f.s. release assumed through sluices.

The crest will be at elevation 651.0 m.s.l. Concrete walls 5 feet high will be provided at the ends of the spillway crest. The entrance channel invert will be at elevation 631.0 m.s.l., for a distance of 230 feet, then will slope upward at the rate of 1 vertical on 10 horizontal to meet the upstream edge of the crest at elevation 651.0 m.s.l. The exit channel profile will be based on carrying maximum spillway discharges (85,700 c.f.s.) at the critical slope of about 0.6 percent until the channel is terminated into a natural ravine that returns to Voss Creek, and then to the Bourbeuse River at Reiker Ford. The overburden at the spillway will have 1 on 4 excavation slopes to prevent excessive erosion and environmental damage. A 10-foot rock bench will be provided along the overburden rock contact, and a 7-foot chain link fence will be placed on the bench at the toe of the 1 on 4 slope for safety. The rock will be excavated at slopes of 4 vertical on 1 horizontal.

1.4.3. OUTLET WORKS

1.4.3.1. General

The outlet works will be located at the left side of the valley. It will consist of a cut-and-cover conduit with an approach channel, intake structure, service bridge, transition section, and stilling basin. The length of the conduit will be 890 feet from the intake to the downstream portal. Provisions for temperature control of downstream releases will be incorporated into the intake structure. Two 18-inch diameter steel-lined conduits will be provided and could be used to supply water to a fish hatchery. At the present time, however, there are no plans for the construction of a fish hatchery by the Fish and Wildlife Service or the Missouri Department of Conservation.

1.4.3.2. Conduit

The cut-and-cover conduit will be founded on rock at the left side of the valley. A single, oblong-shaped conduit was selected for structural economy and hydraulic efficiency. The conduit will be 12 feet wide by 16 feet high, with a flow area of 161.1 square feet. Four conduit sections with different wall thicknesses will be used to resist the varying hydrostatic and soil loads on the conduit. The invert of the conduit will be at elevation 530.0 m.s.l., at the intake, and 529.0 m.s.l. at the downstream portal. A bulkhead slot will be provided at the downstream portal to permit unwatering of the conduit. Four seepage collars will be provided at the monolith joints within the impervious core of the dam embankment.

1.4.3.3. Intake Structure

The intake structure will consist of a reinforced concrete tower located at the upstream toe of the embankment. Trash beams will be provided at the intake. The intake structure will have two rectangular gate passages 6 feet, 6 inches wide by 14 feet high. This will result in a gate area of about 13 percent greater than the conduit area. A transition section will be provided downstream of the intake structure. The intake structure will be of the wet-well type with wheel-type service gates. Hydraulic operators for the service gates will be located above the top of the flood control pool. One wheel-type emergency gate will be provided for

use in either of the two emergency gate wells. One steel bulkhead will be provided for use in either bulkhead slot. The upstream side of the bulkhead slots will be closed below the service platform at elevation 625.0 m.s.l., and covers will be provided at the service platform to prevent flow through the bulkhead slots. An operating house with floor at elevation 683.0 m.s.l. will be provided. An overhead crane will be provided therein, for maintenance work on the service gates and operating equipment, and for installation and removal of the emergency gate and bulkheads. A service bridge with deck at elevation 683.0 m.s.l. will be provided for access to the intake structure from the left abutment of the dam. A low-flow sluice will be provided and the hydraulic operator for the gate will be located on the service platform at elevation 625.0 m.s.l. The water temperature control features, will be located at the upstream side of the intake structure and will be constructed as an integral part thereof. The intakes for the fish hatchery conduits will be located at the right side of the intake structure.

1.4.3.4. Water Temperature Control Features

The water temperature control features will consist of a reinforced concrete deflector wall located upstream of the conduit intakes, and constructed as an integral part of the intake structure. The top of the wall will be at elevation 599.0 m.s.l., which is 20 feet below the top of the joint-use pool. Warm water releases will be drawn over the wall from the upper part of the pool. The length of the top of the wall will be about 80 feet, which will result in the mean flow velocity being less than 3 feet per second for flood control releases of 4,000 c.f.s. When the water surface is below 619.0 m.s.l., the required releases will be much smaller, and can be drawn over the top of the wall even though the water surface may have dropped several feet below the top of the joint-use pool. To provide for releases when the water surface drops even lower, a 16-foot-wide slot will be provided at the upstream side of the structure. The slot will extend from the invert at elevation 530.0 m.s.l. to the top of the wall at elevation 599.0 m.s.l. Concrete stoplogs will be provided and will be removed from the slot, as necessary, to make releases when the water surface is near or below the top of the wall. Since the height of each stoplog will be about 3 feet, warm water releases will be possible at any water surface elevation by removing only enough stoplogs to permit the desired releases to be made. The top of the stoplogs will, at all times, be kept a sufficient depth below the water surface to prevent the water surface within the structure from dropping below the water surface in the lake. The 16-foot-wide stoplog slot will also be utilized for construction diversion and emergency drawdown of the lake. Bulk filler material such as rigid-foam insulation will be attached to the ends of the stoplogs in order to prevent foreign material from completely filling the space at the ends of the stoplogs. This material will insure that the stoplogs can be rapidly removed after an extended period during which they have not been removed. Storage slots for the stoplogs will be provided above the conduit intakes. A crane will be provided for placement and removal of stoplogs and for transporting them to their storage slots.

1.4.3.5. Conduits for Fish Hatchery

The Missouri Department of Conservation has expressed an interest in the feasibility of constructing a fish hatchery immediately downstream of the dam. In order to accommodate this type of a facility, it would be necessary to include in the project design two 18-inch diameter steel-lined conduits with intakes at elevations at 609 m.s.l. and 584 m.s.l. to provide water supply to the hatchery. The intakes for the conduits would be located at the right side of the intake structure adjacent to the service platform. Trash racks and sluice gates would be provided at both intakes. Flow through the conduits would be controlled downstream of the dam; therefore, the sluice gates would be infrequently operated. A portable power unit would be provided for their gate operators. The hatchery conduits would be located along the right side of the outlet conduit in a concrete encasement. The conduits would be terminated at a manhole adjacent to the stilling basin. By-passes with gate valves would be provided at the manhole for flushing.

1.4.3.6. Stilling Basin

The stilling basin design was based on flood control releases of 4,000 c.f.s. The stilling basin will be 64 feet long by 21.5 feet wide. The floor of the 27-foot long chute will have a parabolic drop from the conduit invert at elevation 529.0 m.s.l. to the stilling basin floor at elevation 516.5 m.s.l. The top of the stilling basin walls will be at elevation 545.0 m.s.l., which is above the tailwater elevation corresponding to maximum releases during emergency drawdown. Chute blocks and baffles will be provided. A bulkhead slot will be provided at the downstream portal for dewatering of the conduit. The stilling basin will be designed as a U-frame structure. Floor drains and uplift anchors will be provided. A manhole will be provided at the right side of the stilling basin as a terminal for the fish hatchery conduits.

1.5 SECONDARY STRUCTURAL FEATURES

1.5.1 RELOCATIONS

Construction of the project will involve certain remedial measures to one section of state highway, two sections of county highways, power and telephone lines, and 150 graves in private and public cemeteries. The plan of relocation for each road or utility has been discussed with the owners or their authorized representatives and has been generally accepted.

Construction of the reservoir will require the relocation of approximately a one-mile section of State Highway 185. This relocation will be designed and constructed under an advance financial participation, cost reimbursable contract with the Missouri State Highway Commission. The project is now in the design stage and will be built to an elevation compatible with Union Lake requirements.

Franklin County roads 208 and 234 will require alteration due to construction of the lake. These total approximately one mile in length.

Preliminary field investigations indicate there are at least two cemeteries within the project limits. Of these, one will probably

require relocation, the other, on private lands in a recreation area but above flood control pool, will be fenced. The relocations involve approximately 150 burials.

1.5.2 PROJECT AREA CLEARING

The proposed clearing of the lake area includes the removal of timber, buildings, fences, bridges, houses, and all other obstructions. Approximately 157 building sites would be cleared with the majority being within the normal pool of the lake and the remainder being within the flood control pool or the public recreation areas. Generally, all land below elevation 622.0 m.s.l., 3 feet above the normal or joint-use pool, will be cleared. However, there is flexibility in policies regarding clearing of timber and consideration will be given all possible clearing combinations. The alternative considerations will be coordinated with all appropriate agencies to assure a satisfactory balance between esthetic values, fish and wildlife habitat, boating safety, water quality, and public health.

All downed timber will be disposed. Time has been allowed in the construction schedule to permit timber salvage. Disposal of the products of clearing would conform to applicable federal, state, and county regulations. Products of timber clearing would be utilized to the maximum extent possible with encouragement of the contractor to dispose of wood materials commercially. Buildings and improvements which are considered to have a salvage value are either retained by the former owner for removal from the site or advertised and sold by the Government and removed from the site by the purchaser.

Dug water wells and cisterns within the project lands would be filled with earth material. Drilled water wells within the lake and project boundaries would be sealed or plugged in a manner to prevent pollution of ground water.

1.5.3 RECREATIONAL DEVELOPMENT

Thirteen areas encompassing 5,840 acres have been selected to serve the initial and future public recreational needs at Union Lake. Facilities provided, all or in part by the Corps of Engineers, will include roads, parking units, picnic shelters, comfort stations, shower and laundry buildings, and boat ramp lanes. Water and sewage facilities necessary to accommodate these recreation facilities will also be provided. Additional facilities will be provided by the State of Missouri and private concessionaires. Recreational areas to be developed are shown on Plate 4.

An additional 4,200 acres have been proposed for acquisition in the upper reaches of the lake. These remote locations would provide opportunities for implementing conservation practices, improved hunting and fishing access, nature study and interpretation, bird watching, and primitive camping, as well as help protect the upper reaches from unwise development.

1.5.4 ADMINISTRATION BUILDING AND MAINTENANCE FACILITIES

The administration building and maintenance facilities are located in one complex near the right abutment of the dam, functioning together, but visually separate from each other. The separate approaches, separate parking facilities, and grade separations prevent the visiting public from viewing the maintenance operations. A functional connection between the administration building and maintenance shed is provided by means of a stair.

1.5.5 OVERLOOK SHELTER

An overlook structure will be located on the right abutment. The structure will be of timber construction, and afford a view of the dam and its immediate surroundings.

1.5.6 ROADS AND OTHER FEATURES

Approximately 14 miles of access and service roads will be constructed on project lands. Parking areas will be provided at the administration building, the overlook area, and at recreational areas.

1.6 NON-FEDERAL FEATURES

1.6.1 FISH HATCHERY

The Missouri Department of Conservation has expressed an interest in the feasibility of constructing a fish hatchery immediately downstream of the dam. If constructed, water releases and project land would be made available for its operation at no expense to the Missouri Department of Conservation.

1.6.2 STATE PARKS

A tentative agreement has been reached with the Missouri Park Board to grant that state agency 2,900 acres of land in recreation areas 3 and 6 to be operated as state parks (See PLATE 4).

1.7 DESIGN CONSIDERATIONS

Design investigations for Union Lake included examinations of geologic conditions to document the potential impact on the surrounding area and the integrity of the structure. The investigations included study of pertinent published geological literature and topographic maps, field reconnaissance, geologic mapping, extensive soil and bedrock sampling, laboratory and in-place field testing of the soil and bedrock materials and field tests and low-flow measurements to determine the leakage characteristics of the foundation materials. The three most significant areas of geologic concern are the effects of earthquakes, foundation stability, and foundation and reservoir leakage.

1.7.1 EARTHQUAKE PRECAUTIONS

The Union Lake is located in Zone 1 of the seismic risk map of the United States developed by ESSA-Coast and Geodetic Survey. The design of Union Lake Dam will be predicated on the occurrence of a minor earthquake in the immediate vicinity of the dam with the proper factor of safety as specified by current Corps of Engineers design criteria. Under these conditions, the chance of earthquake damage that would result in dam failure is considered very remote.

1.7.2 STABILITY AND LEAKAGE

Foundation materials and conditions for the Union Lake Dam were thoroughly investigated to determine stability and leakage conditions. Laboratory and field tests and investigations were made of the strength characteristics of the soil and bedrock. Leakage characteristics were studied during the sub-surface exploration period to develop the plan best suited to prevent leakage and development of high internal water pressure which could cause failure of the structure. The results of these tests and the information gained from them will be used in the embankment design.

1.8 ACQUISITION REQUIREMENTS

Total lands to be acquired for the Union Lake would consist of approximately 23,885 acres. Of this total, 21,993 acres would be purchased in fee and 1,892 acres acquired as flowage easements. These lands (acres) are classified in Table 3 by type.

Table 3. Land and property acquired for Union Lake (acres).

	Fee	Easement
Subdivision Land	40	
Home sites and recreational	144	1
Farms (cropland)	8,574	1,326
Brush and timber	12,733	374
Water courses	502	191
Total	21,993	1,892

Types of improvements located on the above properties consist of:

Farm buildings	100
Cabins, cottages, lodges, and residences	55
Commercial buildings	2

Land for the Union Lake project will be acquired in accordance with the revised 1962 Joint Land Acquisition Policy of the Departments of the Interior and Army adopted in February 1962.

In general, the land acquisition policy contemplates that fee interest would be acquired to elevation 619 feet, m.s.l., plus a reasonable freeboard, or 300 feet horizontally from the top of the joint-use pool elevation 619 m.s.l., whichever is greater. In addition, adequate area to provide for public use and recreation during the life of the project will be acquired at the 13 public access areas indicated on PLATE .

Consideration by the Corps of Engineers is being given to granting an exception to the 300-foot criteria where such acquisitions would require the taking of highly developed areas and in certain steep bluff areas where lands are well above elevation 619.0 m.s.l. An additional exception to the 300-foot criteria, will be in the upper reaches of the lake on the Bourbeuse River and tributaries where flowage easements in lieu of fee acquisitions will be acquired.

In the interest of fully informing landowners as to how they will be affected by the project and what portion of their property will be acquired, section and sub-section corners will be re-established in the vicinity of the lake. The perimeter of the project or the taking line which will be the boundary between private and Government lands will then be marked. Wherever possible this will be done before the land is purchased.

1.9 PROJECT OPERATION

The plan of operation of the Union Lake is to maintain the level of the lake as near to the top of the normal or joint-use pool as possible. Once the lake is filled to the top of the joint-use pool, releases will approximate inflows except during floods and droughts. This will encourage river fluctuations similar to existing conditions. During floods, a fixed flood release will be made and all additional inflow will be stored. Simulated reservoir operation studies for a 47-year period of record showed 709 days when inflow to the lake would have exceeded 3,000 c.f.s. (3,000 c.f.s. was used as a conservative fixed flood release). While flood releases from the lake did not exceed 3,000 c.f.s. (about three-quarter bankfull at the damsite), these studies did show that releases of 3,000 c.f.s. were necessary for 1,874 days to evacuate stored floodwaters. In short then, flows at or above three-quarters bankfull occurred at the damsite about 15 days per year under natural conditions. With the dam assumed in-place, flows at the damsite would have been at, but not above, three-quarter bankfull for about 40 days per year.

The operation of the project with regard to the project purpose is discussed below.

1.9.1 RECREATION

The Union Lake at normal or joint-use pool will have a surface area of 6,600 acres. The maintenance of this pool at approximate elevation 619 m.s.l., together with the attendant 17,285 acres of project lands surrounding the lake will support an annual visitation of 1,878,000 recreationists within the first 3 years of project life. Visitation is expected to increase as additional facilities are added. Approximately 1,438,000 visitors will be accommodated on Corps-constructed recreation facilities

and the balance of state, local government, or private lands. When operative, Union Lake will increase the opportunity for improved float trips on the Bourbeuse and Meramec Rivers downstream of the dam. This includes about 32 miles on the Bourbeuse between the Union Dam and the confluence of the Bourbeuse and the Meramec, and about [illegible] miles on the Meramec between the confluence of the Meramec and Bourbeuse to the Mississippi River. Both rivers will have a more uniform flow in the lower reaches due to releases for water supply and water quality. The necessity of portaging and pulling boats around or over shoals will be substantially reduced during times of drought. These releases will alleviate stream pollution, reduce health hazards, and enhance boating and swimming recreational activities downstream of the dam. The control of floods by the impoundment will increase the number of days on which float trips are possible, stabilize the banks, and improve channel conditions. Above Union Lake, natural physical river conditions will continue. Attractive floatable water will remain from Highway 19 to the head of Union Lake, a [illegible], [illegible]-mile float. In a wet season, the float distance will be greater. In addition, Union Lake will have a shoreline of 100 miles which will be accessible to the public and a water surface area at normal pool of 6,600 acres available for general recreation.

Approximately 5,840 acres of recreation lands with facilities developed for high intensity use will be available on the project. These lands are in [illegible] strategic locations and vary in size from [illegible] to 2,02[illegible] acres. (See Plate [illegible]). The Missouri State Park Board, the Missouri Department of Conservation, and the Corps of Engineers will provide recreational facilities suitable for camping, picnicking, swimming, and general recreation pursuits on these areas. Comfort stations, central shower and laundry buildings, water supply and sewage treatment facilities will be provided. Certain tracts will be leased to concessionaires to provide boat docks, storage, overnight accommodations, supplies and items required by the recreationists. The use and development within the public lands will be planned and controlled.

1.9.2 FLOOD CONTROL

The flood control purpose of the Union Lake will be effected by impounding the standard project flood or a runoff of 7.37 inches from the 77[illegible] square mile drainage area above the dam site. This would amount to a storage of 303,100 acre-feet between elevations 619 and 651 m.s.l., while the regulated outflow of 4,000 c.f.s. (bankfull) was released through the outlet works. The retention of this storm runoff of 7.37 inches would furnish a high degree of protection to 7,020 acres in that portion of the Bourbeuse River valley between the dam and the confluence of the Meramec and Bourbeuse Rivers. Partial protection would be afforded an additional 21,920 acres of land in the lower Meramec Valley between the mouth of the Bourbeuse River and the confluence of the Meramec and Mississippi Rivers. The entire 21,920 acres will have a high degree of protection against flooding when the system of five major reservoirs proposed for construction in the basin is completed.

Major Meramec River floods have occurred on the average of about once every six years. However, portions of the bottomlands have experienced flooding almost annually. The highest flood of record, August 1915, covered the entire lower valley from bluff to bluff. From 1930 to the present, the Meramec River Basin has experienced 24 damaging floods. In addition to the many thousands of acres of farmland, the towns of Fenton, Kirkwood, Times Beach, Valley Park, Pacific, Glencoe, and Cedar Hill have experienced flooding. Since Union Lake will control the runoff from almost 20 percent of the Meramec Basin, the flooding in the lower basin will be reduced.

1.9.3 WATER SUPPLY

The storage for water supply of 92,500 acre-feet of water (evaporation and transmition loss included) in the joint-use pool can be released when required to meet the requirements for water supply in the lower Meramec Basin during periods of low flow. This storage will also be available for water supply withdrawal by towns above the dam near Union Lake.

In the lower Basin, ground water is supplemented by withdrawals from the Meramec and Missouri Rivers. Water supply demands were furnished by the Public Health Service on a seasonal basis for three time periods - 1970, 2020, and 2070. Based on these data, supplemental water supply requirements were determined. It was found that by utilizing all available sources, the project requirements in the lower basin can be satisfied until about the year 1980, after which other sources will need to be developed.

The lake will be able to supply a minimum of 71 million gallons of water per day. This is sufficient to furnish each of 330,000 people with approximately 150 gallons per day.

1.9.4 FISH AND WILDLIFE CONSERVATION

The normal pool of Union Lake will have a surface area of 6,600 acres. The U. S. Fish and Wildlife Service estimated (28 January 1964) that there will be a net increase of 250,690 annual fisherman days with the project. This increase is composed of 240,370 days on the lake area and 10,320 days on the downstream reaches. The outlet works design will provide for the discharge of warm water at all lake stages. This provision will help insure preservation of the existing downstream fishery. The overall fishery resources will be increased by the creation of a large lake fishery, regulation of the stream flow below the dam. Water releases and land downstream of the dam would be made available at no expense, for use in establishment and operation of a fish hatchery by the Missouri Department of Conservation if such a facility is considered appropriate and agreed upon with the Department.

The U. S. Bureau of Sport Fisheries and Wildlife reported 11 June 1963, that there are "more than 1,300 miles of permanent stream" in the Meramec Basin. Approximately 10 percent of these streams or 130 miles will be converted to lakes by the five authorized projects. These reaches will be replaced by 415 miles of lake shoreline. Union Lake at normal pool will inundate 36 miles of the Bourbeuse River, and about 11 miles of smaller tributaries. None of the latter are canoe waters, and some are not permanent streams.

Throughout the project, there will be large areas of project fee lands acquired for other project purposes that will be left in a natural or wild state. A major portion of these lands will be included in a subsequent license to the Missouri Department of Conservation for fish and wildlife management purposes under provisions of a "General Plan and Cooperative Agreement" as required by the Fish and Wildlife Coordination Act of 1946 and as amended.

1.9.5 NAVIGATION

The navigation project purpose assigned to Union Lake is achieved incidently on the Mississippi River during low-flow periods by the release of water for water supply, low flow augmentation and improved downstream fisheries.

1.9.6 AREA DEVELOPMENT

The project purpose is achieved by Union Lake through the local employment during construction of the dam and facilities and, subsequently, for the operation and maintenance of the lake. The benefits were based on the savings in unemployment compensation. The amount of savings was assummed as equivalent to the value of the wage component for local labor since it is a primary means of providing work opportunities for those presently on relief rolls.

Area development has been added as a project benefit pursuant to Senate Document No. 97, 87th Congress, and the wishes of the Senate Appropriations Committee as discussed in Senate Report No. 1405 on the 1969 Public Works Appropriations Bill. This category includes only the benefits attributable to value of the direct labor that will be used in project construction and operation which, in the absence of the project, would otherwise be unemployed. Additional benefits representing the impact of the project on the local economy have not been included. These additional benefits would accrue through the development of tourism and recreational industries.

1.10 SUMMARY OF PROJECT BENEFITS AND COSTS

The project benefits are those contained in House Document No. 525, 98th Congress, 2d session. The current average annual benefits and charges, updated to reflect 1 July 1974 price levels, are presented in Table 4.

Table 4. Annual benefits and costs.

Benefits	Current Estimate	Percent of Current Total
Flood Control	$1,292,700	33
Recreation	1,784,000	45
Augmentation of Stream Flow	0	0
Water Supply	542,000	14
Fish and Wildlife	291,000	7
Area Development	46,000	1
Navigation	11,000	trace
Negative Benefits	-9,700	
Total Annual Benefits	$3,957,000	100
Total Annual Costs	2.566.000	
Benefit-Cost Ratio	1,54 to 1.	

1.11 RELATIONSHIP OF PROJECT TO MERAMEC BASIN PLAN

The relationship of Union Lake to the plan for the development of the Meramec Basin can best be placed in perspective by considering the needs of the Basin and then determining what portion of those needs the Union Lake will satisfy.

The object of the Meramec Basin study was to devise a sound plan for the development of water and related land resources to meet the immediate and long-range needs of the basin in an orderly, efficient, and timely manner. In the case of Union Lake, it was determined that the major primary project benefits were flood control, water supply, low flow augmentation/regulation of stream flow, recreation, fish and wildlife, and navigation. The applicable benefits and separable costs of each project purpose, based on a 100-year economic life, were determined, and the relative benefit-cost percentage was allowed to seek its own level of importance.

The Meramec Basin Plan and the Union Lake, as presently formulated and authorized, were coordinated with, and took into consideration the programs and views of 23 federal and state agencies. The opinions of other quasi-public and private organizations were solicited and considered. Consequently, the plan for the development of the Meramec Basin, in general, and the Union Lake, in particular, was the product of professional planning effort and concensus of a broad spectrum of informed and affected citizens in the Meramec Valley and St. Louis Metropolitan Area.

After establishing the basin needs, and those portions of these needs that each lake would satisfy, the value of the satisfaction of the needs was quantified in terms of tangible economic benefits. The value of the respective benefits of each authorized lake, updated to July 1974, is indicated in Table 5. It is noted that Union Lake is an important segment of the total plan, accounting for approximately 18.5 percent of the total benefits.

The Comprehensive Study of the Meramec Basin and the recommended plan for development of the basin contemplated that the principal reservoirs would act as a system. However, it will be noted from detailed consideration of that report that, although related, each of the impoundments can be constructed without the others. The tabulation indicates each lake would meet a proportionate part of the basin needs and develop its respective project benefits which make it economically feasible. All the reservoirs acting together would approach total satisfaction of the Basin water resource needs. The construction of a particular lake will have its individual impact on the environment. As the phased construction proceeds, each reservoir's impact will be determined at that particular point in time. The five authorized lakes, Meramec Park, Union, Pine Ford, Irondale, and I-38 Lakes are well located over the entire 4,000 square miles of the Meramec Basin. This arrangement has been carefully planned to bring benefits to the entire basin area, and the Meramec Basin project benefits of flood control, recreation, water supply, water quality, and area redevelopment are equitably distributed.

By review of House Document 525, page 8, which was made part of Public Law 89-789 by reference, it will be noted that local interests would be required to repay the United States for all costs allocated to water supply, in accordance with the provisions of the Water Supply Act of 1958 and the Federal Water Pollution Control Act Amendments of 1961. The "local assurance" requirement, cited as a precedent to construction in HD 525 in effect gives the local interest (in this case the State of Missouri) veto power over the construction of any reservoir.

1.12 PLANS OF OTHER FEDERAL AND STATE AGENCIES

Plans of other federal and state agencies that are related to, or were developed in conjunction with, the Comprehensive Plan for Development of the Meramec Basin, as presented by the Corps of Engineers, are presented below.

1.12.1 U. S. DEPARTMENT OF AGRICULTURE

The U. S. Department of Agriculture's plans for the development of the water and related land resources in the Meramec Basin by the construction of headwater reservoirs under the provisions of Section 6 of the Watershed and Flood Prevention Act (Public Law 566, 83d Congress, as amended). This plan pr vides for the building of structures to form 60 impoundments in the tr ry and headwater streams of the Meramec Basin, --30 multi-purpose reservoirs for flood control and recreation, 14 for flood prevention alone, and 16 for recreation in the Clark National Forest.

Table 5. Annual benefits and charges from the Meramec Basin plan.

(1 July 1974)

Benefits	Meramec	Union	Pine Ford	Irondale	I-38	Angler Sites	Total
1. Flood Control	$3,909,000	$1,292,700	$1,166,000	$ 119,000	$ 168,000		$ 6,654,700
2. Navigation	31,000	11,000	3,000	9,000	1,000		55,000
3. Recreation	2,976,000	1,784,000	3,101,000	971,000	411,000		9,243,000
4. Fish and Wildlife	917,000	291,000	229,000	205,000	28,000	$198,000	1,868,000
5. Stream Flow Augmentation	134,000	-0-	225,000	686,000	378,000		1,423,000
6. Water Supply	975,000	542,000	269,000	16,000	-0-		1,800,000
7. Redevelopment	106,000	46,000	145,000	83,000	43,000		423,000
8. Negative Benefits	- 12,000	-9,700	- 6,000	- 1,000	- 100		28,800
Total	$9,036,000	3,957,000	$5,132,000	$2,088,000	$1,028,900	$198,000	21,439,900
Percent	42.1	18.5	23.9	9.8	4.8	0.9	100.0
Total Annual Charges	4,701,000	2,566,000	3,097,000	1,586,000	851,000	215,000	13,016,000
Benefit to Cost Ratio	1.9 to 1	1.5 to 1	1.7 to 1	1.3 to 1	1.2 to 1	.92 to 1	1.6 to 1

Two of the lake projects in the National Forest are underway, H-25 on the upper Big River is under construction and the Barney Fork Project on Barney Fork, a tributary of the West Fork of Huzzah Creek is in the detailed planning stage. The Forest Service will continue acquiring and managing lands within the National Forest boundary. These lands are managed for fish and wildlife, recreation, watershed, and timber management.

1.12.2 U. S. BUREAU OF OUTDOOR RECREATION

The Bureau of Outdoor Recreation and the National Park Service proposed on 26 October 1969, the establishment of a national recreation area in the Meramec Basin. This facility would be along the Meramec River from its mouth to Meramec Springs Park. The area would include the river and adjacent lands, as well as Meramec State Park, the Huzzah Wildlife Area, and the proposed Corps of Engineers Meramec Park and Union Lake projects. The National Park Service would administer the section from Meramec Springs Park (river mile 168.8) to Times Beach (river mile 34.0), a distance of 134.8 miles, and local agencies would have administrative responsibility for the segment from Times Beach to the mouth of the Meramec; establishment of a commission to plan a regional open space and recreation area along the Meramec River between the mouth and Times Beach and provision for supplemental grants of up to 30 percent, in addition to the existing standard Federal grants of 50 percent for public acquisition or development of lands for recreation along the lower Meramec.

At a meeting held in Jefferson City, Missouri, on 4 March 1970, chaired by the Director of the Missouri State Park Board, and attended by representatives of the concerned federal and state agencies, the Director made the following statement on behalf of the Missouri Inter-Agency Council for Outdoor Recreation: "The Council opposes the present plan for the National Recreation Area proposed by the National Park Service and the Bureau for Outdoor Recreation." An effort was made by representatives of BOR to reconcile the state objections, but without success. The main objections of the state were: (1) The plan leaves the problem of developing the lower river as the sole responsibility of the state and local interests; (2) No opportunity for state review of the plan before publication; (3) The Huzzah Wildlife area and Meramec State Park would not remain under state jurisdiction; and (4) The plan does not provide for rehabilitation of the lower river.

A new study was to be requested by the state from below the Meramec State Park to the mouth of the Meramec River. To date, this new study has not been made.

1.12.3 MISSOURI DEPARTMENT OF CONSERVATION

The Missouri Department of Conservation has expressed an interest in the feasibility of constructing a fish hatchery immediately downstream of the dam on land which would be furnished by the Federal Government. If constructed, water for the hatchery would be furnished from the lake at no cost to the Missouri Department of Conservation.

1.12.4 MISSOURI STATE PARK BOARD

Missouri State Park Board proposes to operate and maintain as part of the State Park system, recreation area 3 and develop, operate and maintain area 6, totaling approximately 2,900 acres. These lands will be furnished by the Federal Government under a long-term lease or outgrant.

1.12.5 MISSOURI STATE HIGHWAY COMMISSION

RELOCATION AND ALTERATION OF MISSOURI STATE HIGHWAY 185

1.12.5.1 Location and Description

This project is a spot improvement (bridge repla[illegible] approximately 1.0 miles in length, located 2.0 miles south of Beau[illegible] [illegible] Noser Mill.

The proposed alignment begins on the centerline of present Route 185 approximately 1.5 miles south of Beaufort and U.S. 50, then runs southerly on the east side of the existing road for approximately 1.0 mile crossing the Bourbeuse River 900' downstream from the existing bridge, and ending on the centerline of present Route 185.

The proposed improvement will consist of two 12' high type surfaced travel lanes with 8' stabilized aggregate shoulders and safety zones on each side of the travel lanes. Limited access right-of-way will be acquired at the county road intersections only. The right of access on the remainder of the project is not limited, however, persons desiring to construct additional entrances to the highway will be required to obtain permits from the Commission's District Engineer to work on state owned right-of-way. The design speed is 60 mph and the 1989 design traffic is 1700 vehicles per day.

The nature of the work, i.e., earthwork and bridge, will be heavy, due to influence of the Union Reservoir which is to be constructed by the Corps of Engineers. This improvement is jointly financed by the Missouri Highway Commission and the U. S. Army, Corps of Engineers.

The present road is below the extreme highwater elevation during flooding conditions of the Bourbeuse River. The proposed bridge approach fills and bridge will be constructed above the flood control pool of Union Reservoir. The difference in cost between a low grade line that would normally be design above the flooding conditions of the river and the high grade line that is required to accommodate the flood control pool of the reservoir will be borne by the U. S. Army, Corps of Engineers.

1.12.5.2 Purpose of the Project

The purpose of this project is to replace a narrow (16 foot wide) and dilapidated high truss bridge over Bourbeuse River and to reconstruct the approach fills above the flood control pool of Union Reservoir. Replacement of dilapidated bridge structures on the present Secondary Road system is part of the Five-Year Right-of-Way and Construction Program. The bridge and approach fills will be constructed in cooperation with the Corps of Engineers to provide an all-weather crossing of the flood control pool of Union Reservoir.

1.13 RECENT WATER QUALITY LEGISLATION

Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972) includes changes affecting the respective responsibilities and functions of the Corps of Engineers and the Environmental Protection Agency with regard to storage for streamflow augmentation. Section 102(b)(3) of the Act declares that the Administrator of the Environmental Protection Agency shall determine the need for, and the value of, and the impact of storage for water quality control, and his views on these matters shall be set forth in any report or presentation to Congress proposing authorization or construction of any reservoir including such storage. However, under Section 102(b)(2) of the Act, the Corps of Engineers (or other Federal agency as appropriate) retains the responsibility to determine the need for and the value of storage for regulation of streamflow (other than for water quality) including but not limited to navigation, salt water intrusion, recreation, esthetics and fish and wildlife. It is noted that the State of Missouri has two agencies responsible for water quality control. The Clean Water Commission for general state wide quality control and the Department of Conservation for water quality relating to the needs of fish.

The Corps has determined that Section 102(b) of the 1972 Amendments apply to the Union Lake project. Accordingly, on 25 June 1973 the Corps, St. Louis District office, in letter to the administrator of the Environmental Protection Agency, Kansas City, Missouri, requested that agency to furnish information concerning "the need for, the value of and the impact of, storage for water quality control" in the Union Lake project. By letter dated 5 October 1973, the Regional Administrator for the EPA Region VII, Kansas City, Missouri, advised that storage allocation in the Union Lake project for flow augmentation for water quality control cannot be supported. Other provisions of the Federal Water Pollution Control Act Amendments of 1972 may effect the future operating of the Union Lake project. Those portions of the 1972 Amendments which would most likely affect the project are summarized below:

1. Not later than 1 July 1977 point sources, other than publicly-owned treatment works, shall require the application of the best practicable control technology currently available as defined by the Administrator (of EPA).

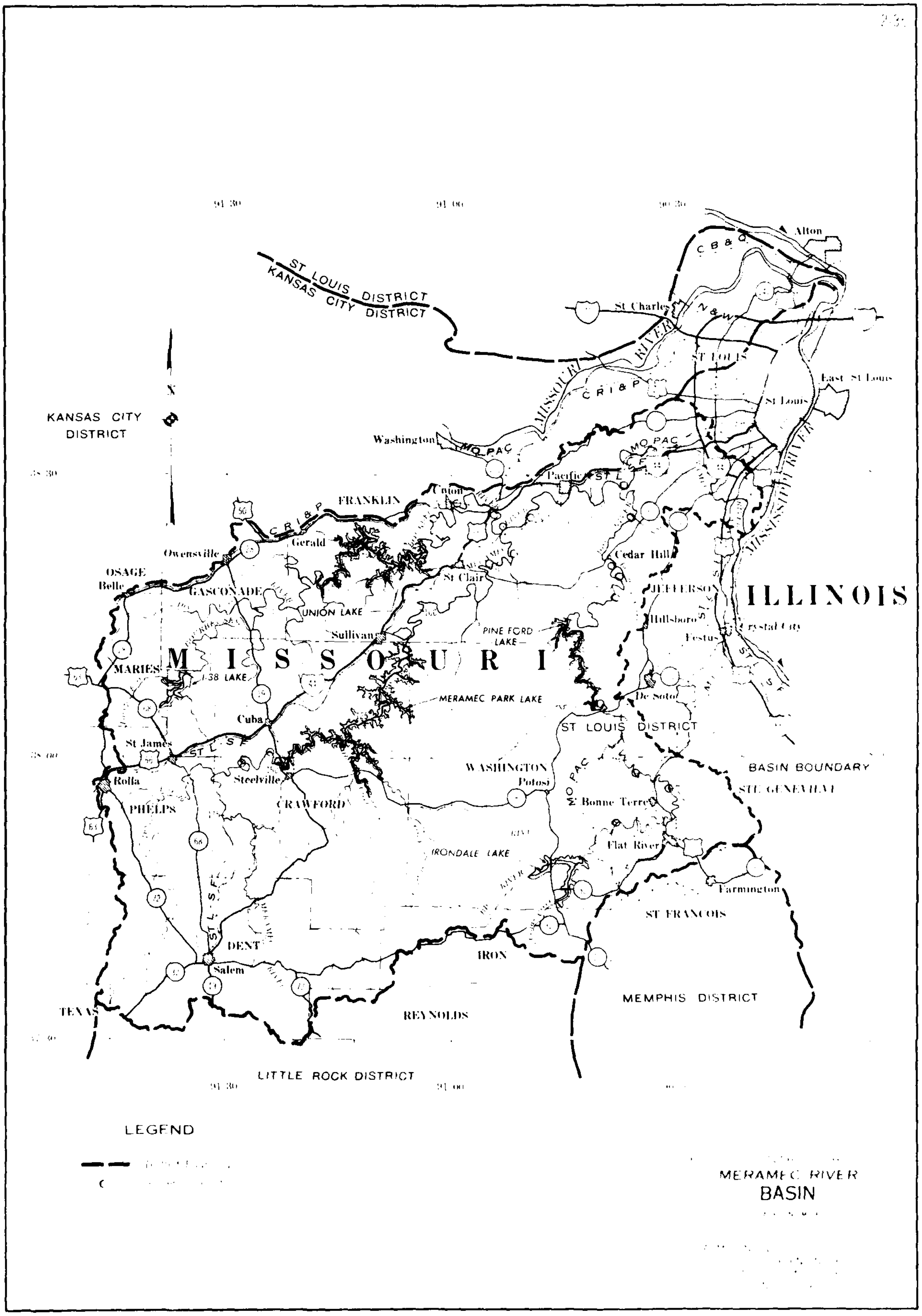
2. Publicly-owned treatment works in existence as of 1 July 1977 or approved for construction prior to 30 June 1974 must provide effluent limitations based upon secondary treatment as defined by the Administrator. Secondary treatment was subsequently defined as a minimum of 85 percent BOD removal by the Administrator.

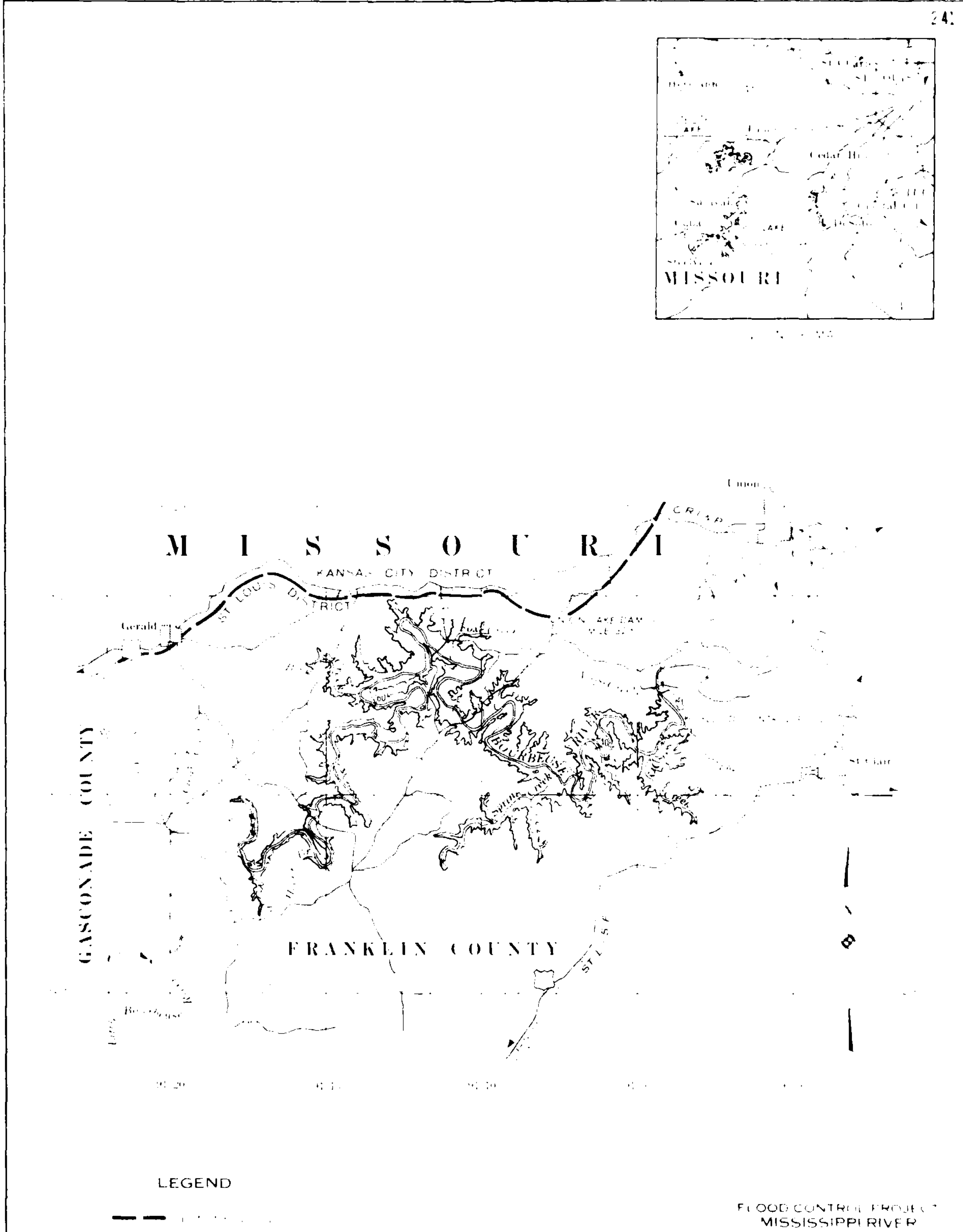
3. Not later than 1 July 1983, point sources shall require the application of the best available technology economically achievable.

4. Establishment of zero discharge of pollutants by 1985 as a National goal.

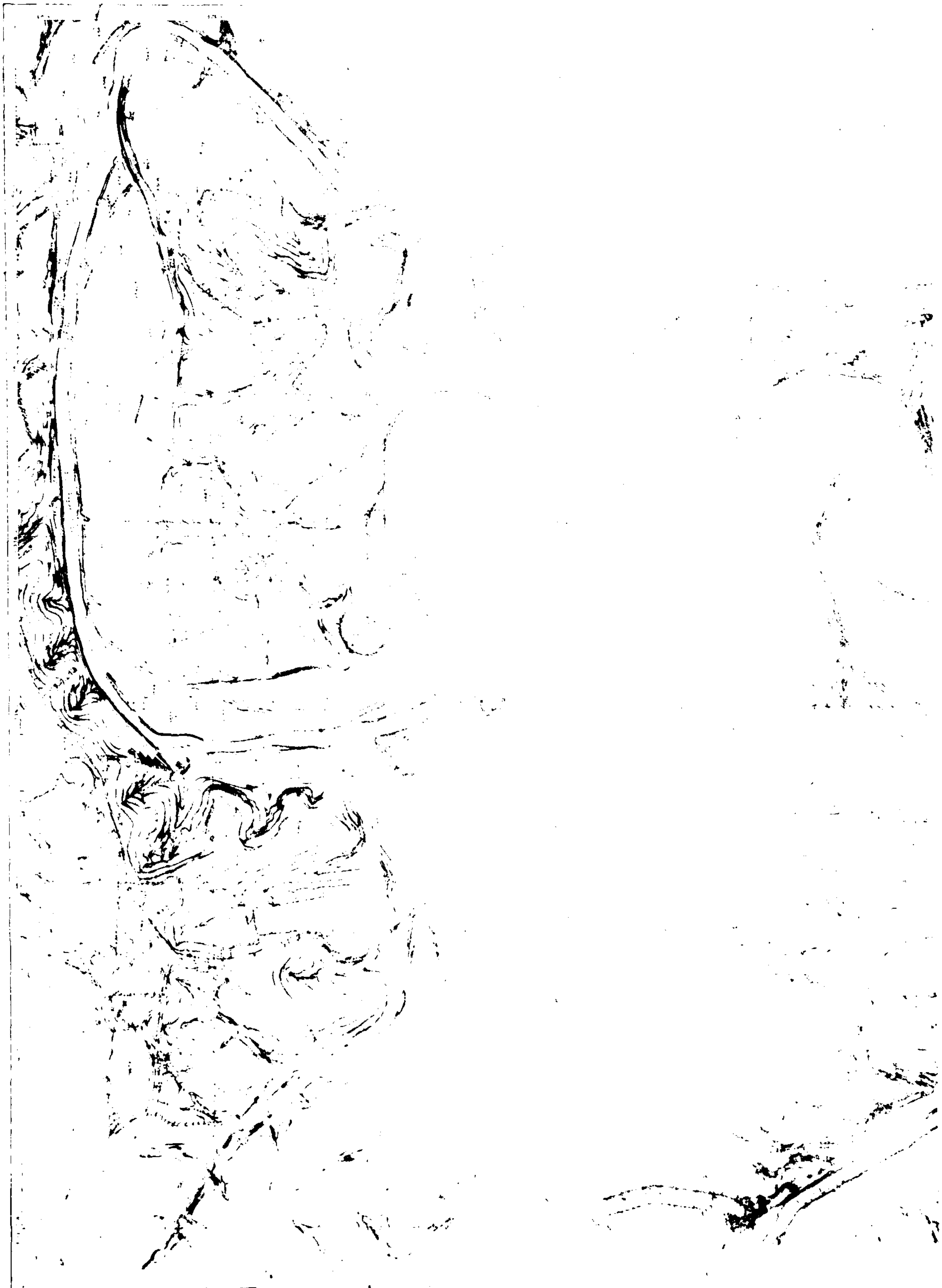
5. Requirement that each state submit to the Administrator by 1 January 1975 a report which will include a description of the nature and extent of non-point sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the cost of implementing such programs.

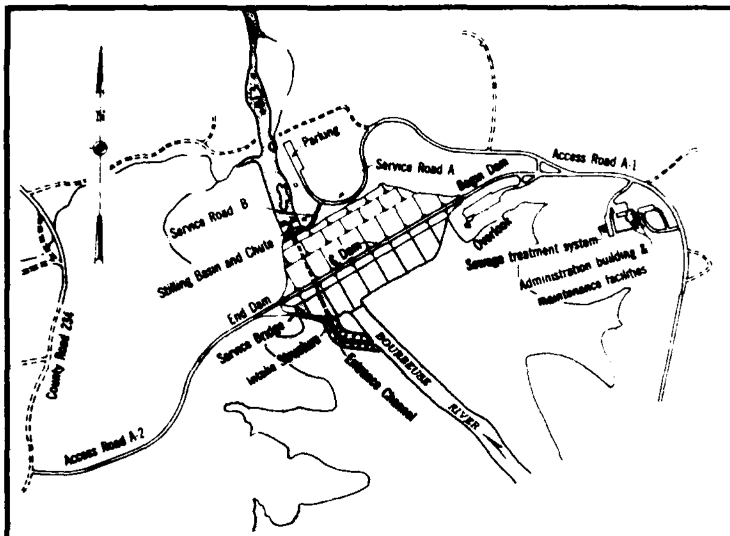
Water quality benefits and storage: The statutory mandates of Public Law 92-500 indicate that pollution of navigable waters must cease by 1985. Construction of Union prior to the Federal Water Pollution Control Act Amendments of 1972 did not take place. Henceforth, no water quality benefits and storage can be claimed. This act does not preclude stream flow augmentation as a project purpose. The Corps looked into the matter of subjoining stream flow as a viable inclusion but found this not to be a supportable or practicable addendum at this time. Stream flow augmentation could be claimed for canoes and fishermen if the flows along the Meramec and Bourbeuse Rivers needed augmentation. Preliminary investigations indicated that, for canoeing purposes, a minimum of one foot of water is required. A review of a 37-year period of record indicated that Meramec River flows had not gone below 130 cfs (1.5 feet at Pacific) and only twice in recorded history has it reached this low point. Thus, there does not appear to be rationale for stream flow augmentation as a purpose. Further, the Meramec Park reservoir will stabilize flows without the Union project, suggesting that the heretofore natural flow minimum of 130 cfs will probably not be experienced again. Augmentation along the Bourbeuse River is not considered necessary for the same reasons. Therefore, the Union Lake project does not include reservoir storage for any type of flow augmentation. The present plan does include reservoir storage for recreational purposes incorporating approximately the same volume previously allocated to water quality.


ST LOUIS DISTRICT
KANSAS CITY DISTRICT
KANSAS CITY DISTRICT
Alton
C B & Q
St Charles
N & W
MISSOURI RIVER
ST LOUIS
East St Louis
St Louis
C R I & P
Washington
MO PAC
Pacific
ST L
Union
FRANKLIN
C R I & P
Gerald
Owensville
OSAGE
Belle
GASCONADE
St Clair
Cedar Hill
JEFFERSON
ILLINOIS
UNION LAKE
Sullivan
PINE FORD LAKE
Hillsboro
Festus
Crystal City
MISSISSIPPI RIVER
MARIES
M I S S O U R I
I-38 LAKE
MERAMEC PARK LAKE
De Soto
Cuba
ST LOUIS DISTRICT
St James
ST L S F
Rolla
Steelville
WASHINGTON
Potosi
BASIN BOUNDARY
PHELPS
CRAWFORD
MO PAC
Bonne Terre
STE GENEVIEVE
IRONDALE LAKE
Flat River
Farmington
ST FRANCOIS
ST L S F
DENT
IRON
Salem
MEMPHIS DISTRICT
TEXAS
REYNOLDS
LITTLE ROCK DISTRICT
LEGEND
MERAMEC RIVER
BASIN



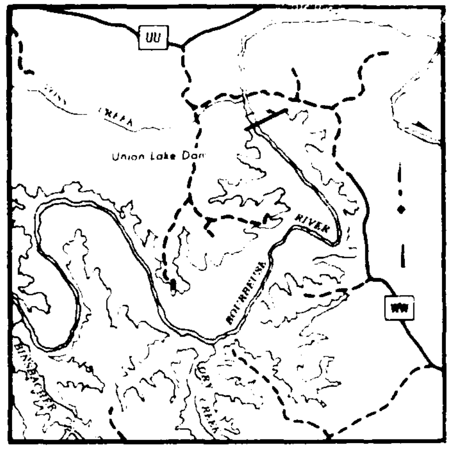
FLOOD CONTROL PROJECT
MISSISSIPPI RIVER
UNION LAKE





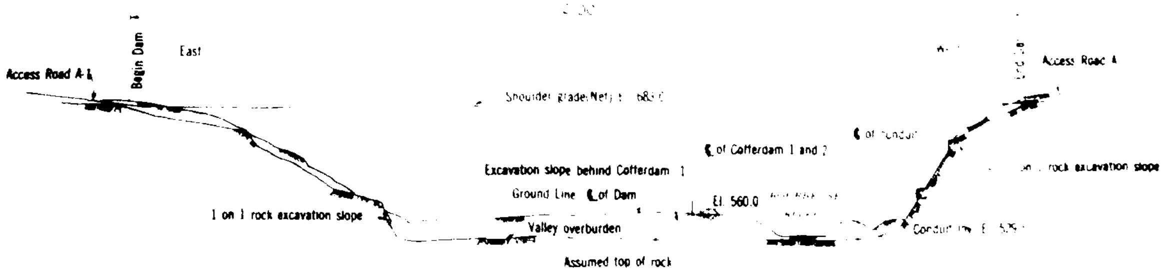
PLAN

SCALE IN FEET

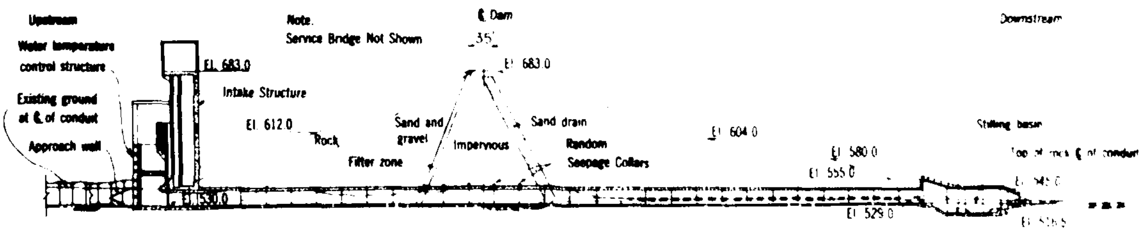


VICINITY MAP

3000 0 3000 6000 9000



AXIS PROFILE LOOKING UPSTREAM



TYPICAL OUTLET WORKS SECTION

SCALE IN FEET

100 0 100 200

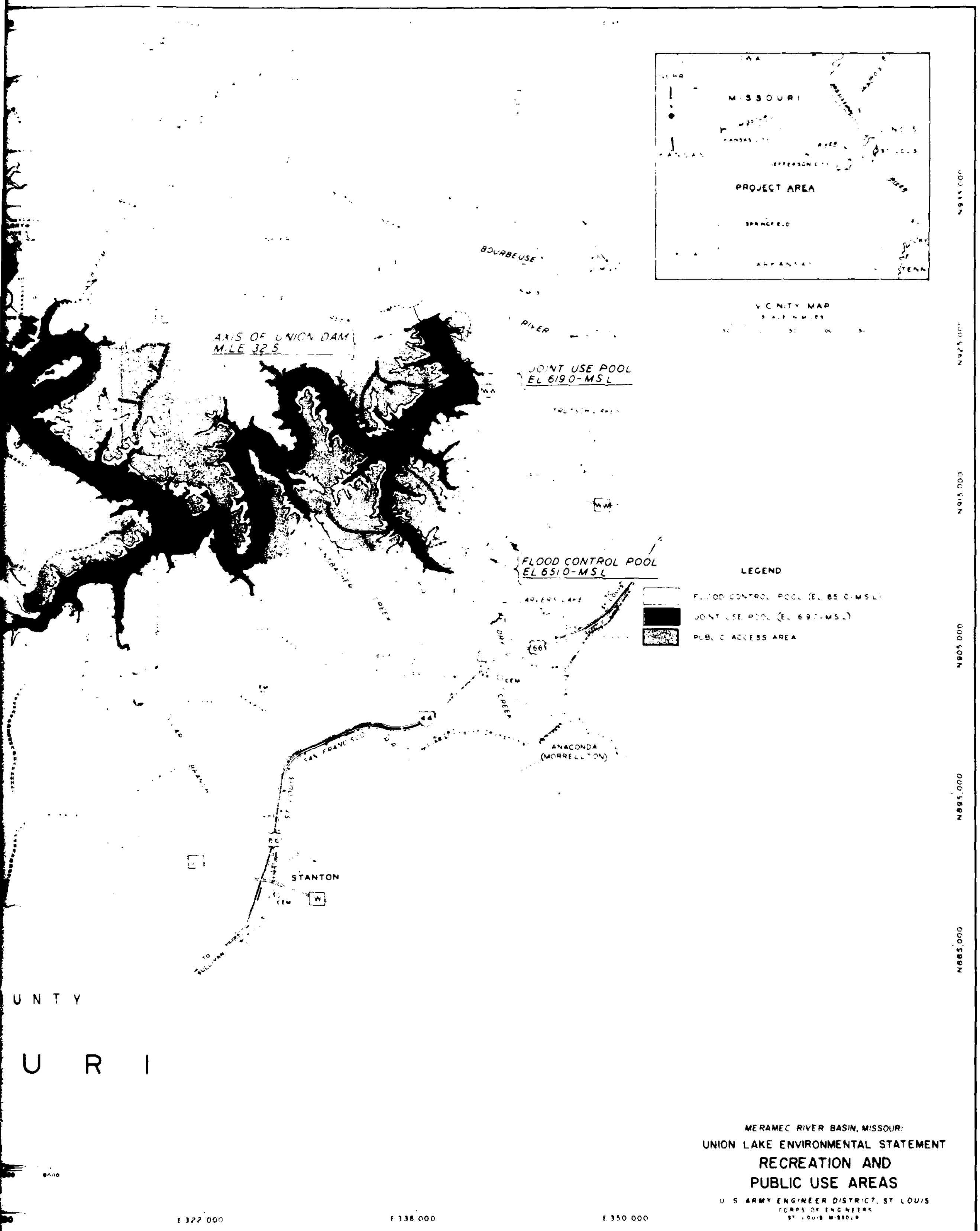
Elevations are in feet above mean sea level

FLOOD CONTROL PROJECT
MISSISSIPPI RIVER
UNION LAKE DAM
BOURBEUSE RIVER MISSOURI
SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
JUNE 30, 1971

PUBLIC ACCESS AREAS

LOCATION	BOATS, MOTORS, BAIT AND REFRESHMENTS	LAUNCHING RAMP	PICNIC GROUNDS	CAMPING GROUNDS	DEVELOPMENT AND OPERATION BY
1			X		CORPS OF ENGINEERS
2	X	X	X		CORPS OF ENGINEERS & CONCESSIONAIRE
3	X	X	X	X	STATE OF MISSOURI
4		X		X	CORPS OF ENGINEERS
5	X	X	X		CORPS OF ENGINEERS & CONCESSIONAIRE
6	X	X	X	X	STATE OF MISSOURI
7	X	X	X	X	CORPS OF ENGINEERS & CONCESSIONAIRE
8			X		CORPS OF ENGINEERS
A-E					RESERVED FOR FUTURE DEVELOPMENT



MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
RECREATION AND
PUBLIC USE AREAS
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

PLATE 4

2. ENVIRONMENTAL SETTING WITHOUT THE PROJECT

2.1 PHYSICAL ELEMENTS

2.1.1 GEOLOGICAL ELEMENTS OF THE MERAMEC BASIN

The drainage basin of the Meramec River lies in the east-central portion of the Ozark Plateau in the State of Missouri. A portion of the southern part of the basin area lies in the St. Francois Mountains and is drained by the Big River, while the Bourbeuse River drains the northern portion of the basin. The Meramec River enters the Mississippi River a few miles south of the city of St. Louis.

The Meramec Basin is characterized by a relatively dissected topography, particularly near the larger streams where they have cut deeply into the upland surface (See Figure 1). Most of the stream valleys are narrow and some have vertical rock bluffs rising over 200 feet above the water courses. The uplands between the streams are rolling with 20 to 50 percent of the area in gentle slopes (Plate 1).

There are many natural springs which contribute to the flow of the streams in the area. Thirty springs have published flow measurements although many other small unmeasured springs are known to be present. The flows vary from an average daily flow of 90 million gallons to a few hundred gallons per day. Comparatively, few large springs discharge into the Bourbeuse or Big River drainage basins.

The oldest rocks in the Basin are igneous rocks which are approximately 1.3 billion years old. They were formed during the PreCambrian period and today form the St. Francois Mountains in the southeastern part of the Basin (Plate 2). As can be seen on Plate 2, the majority of the Meramec River Basin is underlain by sedimentary rocks of Paleozoic age. Most of the rock formations are carbonates (limestone and dolomite) with some sandstones and shales and abundant chert, which is a common constituent of most of the carbonate formations.

Plate 3 illustrates two cross-sections of these formations. Section $A^1 - A^2$ shows the nearly level attitude of the rock strata across the State with several breaks or faults. The doming effect of the Ozark uplift is also apparent as the PreCambrian surface becomes higher from A^2 to A^1. Geologic section $B^1 - B^2$ illustrates the surface exposure of the St. Francois Mountains igneous rocks and the steeply dipping beds east of the PreCambrian materials.

Since Pennsylvanian time, about 270 million years ago, uplift and erosion have apparently persisted. This has resulted in the deposition of alluvial materials in flood plain areas, weathering of rock units and formation of residual soils and development of various solution features (caverns and springs) in the soluble carbonate rocks.

Most of the soils of the Basin (outside of the alluvial soils of the flood plains) are weathered in place from the parent rock. The overlying mantle of weathered material may exceed 150 feet in thickness and reflects the character of the underlying rock. The parent rock in the Basin has weathered to produce the following distinctive types of residuum: (1) The most widespread lithological feature in the basin is cherty dolomite which leaves a cherty clay soil mantle, usually very pervious and attaining great thicknesses; (2) The non-cherty limestone, especially the Plattin and Kimmswick, weather to form clay and silt soils, fairly loose and containing occasional carbonate fragments in their lower levels; (3) Shales of the Basin produce gray to dark gray silts and clays with occasional iron or lime concretions. Some of the lower shales produce ash-like, powdery to sheety residuum of light gray color; (4) Fine, sand loam and cherty, sandy loams are residual from sandstones and cherty, dolomitic sandstones. Roubidoux derived soil generally exhibits a reddish color, while residuum from the St. Peter is usually gray and has a higher sand content. Pennsylvanian sandstones yield soils ranging from red to gray to yellow; (5) The Potosi formation and, to a lesser extent, the Eminence produce a deep red, sticky, clay residuum. This type of clay is distinctive of the Potosi formation, and occurs in considerable thicknesses on gentle slopes; (6) A predominantly yellowish cherty, clay residuum is derived from the argillaceous dolomites of the Jefferson City and related formations. Dependent upon the character of the parent rock, these soils vary considerably in their sand content.

The Meramec Basin area lies near the major earthquake zone of the central U. S. (See Figure 2). This zone includes the "Boot Heel" area of southern Missouri and surrounding portions of Illinois, Kentucky, and Arkansas. The New Madrid earthquakes of 1811 and 1812 were centered in the "Boot Heel" area. Several low intensity earth movements have taken place locally since that time, but the Basin can be considered moderately stable.

2.1.2 GEOLOGICAL ELEMENTS OF THE PROJECT AREA

2.1.2.1 Geologic Setting

The project area is located in the Ozark Plateau Physiographic Province. Along the Bourbeuse River the plateau surface is dissected by stream erosion and a local relief of 500 feet is common (See Plate 4). Topographically the Union Lake area is a region of open hills with 20 to 50 percent of the land surface gently sloping.

The topography of this area is a product of stream erosion and weathering processes, controlled to some extent by flat lying strata and uplifting of the plateau. The Bourbeuse River originates in Phelps County, Missouri, flows in a general northeasterly direction and joins the Meramec River at a point about 13 miles below the City of Union. The Bourbeuse River, above the dam site drains about 754 square miles. The principal tributaries of the Bourbeuse River are Spring Creek, Boone Creek, Red Oak Creek, Little Bourbeuse River, Dry Fork Creek and Brush Creek. The fall of the river from its headwaters is about 726 feet, with an average fall of about 5 feet per mile. In contrast to the Meramec River and Big River in the Meramec Basin, which have an asymmetrical dendritic drainage pattern, the Bourbeuse River has a symmetrical dendritic drainage pattern which has been interpreted as in part due to relatively soft rocks underlying the Bourbeuse Basin. Throughout the watershed, the plateau is deeply incised by its drainage. Valley walls are steep and high rock cliffs and steep bluffs are numerous. In general, the river channel meanders in a relatively narrow and sinuous valley, while the uplands are usually continuous for long distances with only minor undulations along the crest. Elevations along the divides range from about 630 feet at the dam site to about 850 feet at the upper reach of the proposed reservoir.

Several rock formations are associated with the Union Lake area and the dam site (Plates 5 and 6). The Gasconade dolomite is the basal unit of the Ordovician age rocks and forms the valley floor and the valley walls in the lower two-thirds of the proposed reservoir. The unit is from 230 to 240 feet thick in the area and contains a member (the Gunter) that is a reliable source of groundwater for much of the Ozark region. This formation is also a cave former.

Overlying the Gasconade dolomite is the Roubidoux formation which is composed of sandstone and cherty dolomite. This rock unit underlies the upper one-third of the proposed lake, and in the majority of the uplands, the lower average thickness of the Roubidoux sandstone in the project area is 120 feet. The formation is also water yielding, but should be sealed and cased for good water yields.

The Jefferson City dolomite overlies the Roubidoux sandstone and is exposed in the surrounding upland in the upper half of the lake area. The formation is from 125 to 300 feet thick and contains a unit which is used as a dimension stone. Locally, the coarsely pitted material is called quarry ledge.

Several faults are located near the project site (See Plate 7), the most prominent of which is the Leasburg Fault, which runs northeasterly across the project. Several minor faults appear near the dam site and have been confirmed by drilling data. A possible fault site downstream of the dam site that has not been verified will be further investigated. The Leasburg Fault is thought to be moderately active and to be the source of an earthquake in 1943. This quake had an intensity of between 4 and 5 on the Modified Mercalli Scale. (Intensity 5 is considered rather strong. It is generally felt and most sleepers are awakened.) This intensity may be contrasted with the New Madrid earthquakes of 1811 and 1812, which had an intensity of 12. (Intensity 12 results in catastrophic destruction: few buildings remain standing; bridges are destroyed; total destruction is common, as the ground rises and falls in waves.) The dam site lies about 160 miles from the New Madrid zone.

2.1.2.2 Mineral Resources

Deposits of barites, lead, zinc, copper, iron, pyrite, coal and fire clays have been reported in the project area, but only iron, pyrite, and fire clay deposits have economic importance (Plate 6). The fire clay deposits are widely scattered and small, and at present, there is no known extraction of the local deposits. The discovery of iron ore deposits in the deeply buried PreCambrian rocks has revived the mineral industry of the region. Ore is presently being mined at Pea Ridge and the Bourbon deposit in Crawford County is known to be one of the largest magnetite (an iron mineral) in the United States. The Kratz Spring ore deposit lies within the project area. The ore body is also magnetite and the deposit may become exploitable under future economic conditions.

2.1.2.3 Surficial Materials

a. General: The surficial materials of the Union Lake project area are of two types: (1) The uplands are mantled with the residual weathering products of the underlying bedrock which consists of cherty carbonate rocks and sandstones. Also located on the uplands overlying the residual soils are isolated patches of loess, a wind deposited silt of Pleistocene (Ice Age) time. (2) Alluvial soils are found on the flood plain of the Bourbeuse River and its major tributaries.

b. Upland Soils:

(1) General: From an agricultural standpoint, the land capability of the upland soils is not good. The Union silt loam and the Lebanon silt loam, as suggested by the U.S. Department of Agriculture, are classed pasture/forest land. The soils have a low fertility and poor physical properties as well as a high stone content and are susceptible to change in moisture content. As a result the suggested agricultural land use is permanent pasture or forest cover.

(2) Union Soils: The major soil type in the Union project area is known agriculturally as the Union silt loam. This soil, occurring on hillsides, is comprised chiefly of loessial material in the upper portion

of the profile with some residual material present in the lower parts. Due to its derivation from loessial materials, the upper zones are quite permeable and, similar to pure loessial soils, very susceptible to destructive erosion. Thus, along the steeper slopes where erosion has been more severe, the loessial deposits have generally been eroded, keeping a cover of more stable residual materials. The Union soils are generally classed by the Extension Division, University of Missouri, as Classes 4 and 6, i.e., inferior cropland and marginal pasture/forest land. "Low fertility or poor physical properties of the soil results in low productivity and hazardous farming."

(3) Lebanon Soils: The only other soil in significant amounts in the basin area of the proposed Union Lake is the Lebanon silt loam, which occurs on the level areas of the high ridge tops. This soil consists of several feet of a brown to gray gravelly silt loam with an underlying "hardpan" layer which is very impermeable and results in poor internal drainage. Although the upper portion of this soil is a material that normally would be erodible, its high permeability and the very level ground result in water being carried downward into the soil and running off along the upper surface of the hardpan. The Lebanon soils are generally identified as Classes 4 and 6, similar to the Union soils, but with still lower inherent fertility.

c. Bottomland Soils: The bottomland soils in and below the project area belong to the Huntington Group, and are considered good agricultural soils.

The alluvial soils are good crop producers, but hydrologic data has shown that, on the average, overbank flow occurs once a year for the average duration of 10 days. As a result, the alluvial valley of the Bourbeuse is less extensively developed than that of the Meramec River. Sand and gravel deposits of the Bourbeuse River bed are of an inferior type and are not suitable as construction materials.

2.1.3 HYDROLOGIC ELEMENTS

2.1.3.1 General

The Bourbeuse River sub-basin occupies the northwestern portion of the Meramec River Basin. This sub-basin has drainage area of about 848 square miles. The watershed is roughly triangular and is bounded on the north by the Missouri River, on the south by the Meramec River, and on the west by the Gasconade River. The drainage pattern of the tributaries to the Bourbeuse River is symmetrically dendritic (See Figure 3). The Bourbeuse River has its source in Phelps County, Missouri, and follows a course generally parallel to the northern boundary of the Basin, entering the Meramec River at mile 64.8, a distance of about 145 river miles. It has a total fall of about 740 feet with about 50 percent of the fall occurring in the uppermost 18 miles. The flood plain consists of about 22,300 acres along the mainstream with an additional 5,600 acres along tributaries.

2.1.3.2 Climatology

The Bourbeuse River Basin has a humid continental climate which varies considerably. The predominant air masses which influence the Basin's climate come from the southwest, bringing moist air from the Gulf of Mexico and, at times, hot dry air from the desert southwest. The wind velocity during the summer and fall average seven to nine miles per hour; during the spring and winter, the velocity rises to 10 to 12 miles per hour. Winter winds often come from the west and northwest. The annual mean temperature of the basin is about 56° F, with January being the coldest month, with temperatures averaging below freezing, and July and August are the warmest months, with temperatures often exceeding 90° F.

Most of the precipitation occurs in the spring and early fall, usually as showers or thunderstorms. The average annual precipitation in the Basin is 38.5 inches. Flooding occurs most frequently in the spring and early summer from basin-wide heavy rains. Droughts have been experienced both locally and throughout the basin, but normally the humid characteristics of the basin's climate tend to limit the severity and duration of droughts. The average runoff from the drainage area above the Union gage (mile 13.4) is 10.44 inches, or 621 c.f.s. A maximum runoff of 25.13 inches was experienced in 1957; the minimum was 1.79 inches in 1954. Maximum and minimum flow at the Union gage during the 50-year period-of-record (1921-1970) are 33,000 c.f.s. and 11 c.f.s., respectively. The largest spring in the Bourbeuse River Basin is Kratz Spring, near Stanton, which averages 16 c.f.s. Other springs in the basin average less than 1 c.f.s. each.

At the Union gage, the channel capacity of the Bourbeuse River is about 8,000 c.f.s. Major floods of record and corresponding peak stages at the Union gage were as follows:

Table 1. Floods of record on the Bourbeuse River at the Union Gage

Year	Peak stage (ft)
1915	28.5
1920	22.3
1927	22.1
1938	23.2
1943	22.0
1945	23.1
1947	22.1
1957	24.4

Flood stage at the Union gage is 15 feet. This stage has been exceeded two out of three years (on the average) during the 50 years of record. In some wet years, flood stage has been exceeded as many as four or five times per year.

Sediment sampling was performed at the Union gage for the period March 1945 through June 1951. Particle size analyses of samples were run, and the size distribution of suspended material in the Bourbeuse River averaged 49 percent clay, 45 percent silt and 6 percent sand. The finer grained sediments found in the Bourbeuse River Basin are the result of relatively softer rock formations and land use practices which differ from those of the rest of the Meramec Basin. Sediment load computations, based on the sediment rating-flow duration curves method, have shown the average annual suspended sediment yield to be 180 tons per square mile of drainage area passing the Union gage.

2.1.3.3 Water Quality

Water quality of the river and tributaries in the project area is generally good and the water is made potable with little treatment. Although pollution is minimal in the area, all flowing water is susceptible to pollution. Numerous forms of pollution exist within the project areas, but some are of insignificant magnitude. Geological pollution is caused by mineralization leached and transmitted from geologic formations to the surface of sedimentation originating from erosive runoff, especially during floods. Industrial pollution does not seem to present a significant pollution potential. Further stream degradation occurs from agricultural runoff on cultivated lands undergoing severe erosion during heavy precipitation. Fertilizer application to croplands increases the nitrogen and phosphorous levels of the streams and groundwater. Pesticide and herbicide applications to crops enter the streams by surface runoff and groundwater infiltration. High fecal coliform and fecal streptococci bacteria counts during heavy precipitation indicates animal farms, sewage lagoons and faulty septic tanks as pollution sources. The large cattle, swine and poultry population create a potential waste equivalent to a human population of two million people. Much of this untreated waste will enter tributaries due to surface

runoff. Only one of the nine communities in the project area lacks any type of treatment facilities while the remainder have secondary treatment. Residents in the project area not served by collection systems have septic tanks, private lagoons or no treatment. Poor subsurface soil conditions increase pollution potential from these sources. Generally, the quality of the surface water in the project area is suitable for most municipal and industrial water uses after conventional treatment. Although springs are highly vulnerable to pollution, the spring water in the project area is generally of good quality. These springs yield moderately mineralized water with calcium, magnesium and bicarbonate as the predominant constituents.

2.2 BIOLOGICAL ELEMENTS

2.2.1 PLANT AND ANIMAL SPECIES

2.2.1.1 General

Thousands of species of plants and animals are recorded from the Meramec Basin. Although the Basin has been studied for many years by a wide variety of biologists and talented amateurs, undoubtedly hundreds of species which occur there have not been recorded. It should be noted, however, that the possibility of finding new species endemic to the Basin, within the vertebrate or spermatophyte groups, is remote. The taxonomy of other large groups (for example, the lower plants, protozoans, nematodes, arthropods and flatworms) is incompletely understood, and the possibility of a new species from the Basin is recognized.

2.2.1.2 Vegetation

a. General: Knowledge of the vegetation of an area is essential to a thorough understanding of the environment, since vegetation reveals at a glance many characteristics of the ecological elements which influence the environment. These elements include soils, climatic conditions and various biotic features of the environment. The composition of a given plant community is associated with a given set of environmental conditions at a given time, and it reflects landscape qualities which are not completely erased or hidden by man's activities. The presence or absence of a given species, patterns of distribution, and associations with other species are all factors which are useful in evaluating environmental conditions. Even where the natural vegetation has been replaced by substitute communities of cultural vegetation, it is possible to ascertain many characteristics of the environment, since each particular type of natural vegetation has only a definite and defineable number of substitute plant associations. Plate 8 shows the forested areas in the Union Lake project area.

b. Site-types: There are several ways of describing vegetation. In this instance the project area has been classified into four site-types for the purpose of describing the vegetation.

(1) Site-type I (Riverine areas): This site-type consists of the flood plain which lies adjacent to the river. The soils are alluvial; they range from slowly drained, medium textured, medium fertility soils to well drained, fertile, medium textured soils. The natural vegetation was bottomland hardwood forests, but much of the area has been cleared for cultivation and is used for the production of row crops. Typical tree species found on these sites, which are not used for agriculture, include willows, cottonwood, silver maple, river birch, and sycamore. These sites are the most productive forest sites on the project area.

(2) Site-type II (Terrace areas): This site-type is located further from the river on higher ground and is only slightly better drained. These sites are less subject to flooding, and the duration of flooding is less than on the riverine site-types. There is some crop production on these areas, while other uses include grazing and woodlands. These sites are also highly productive forest sites. Species composition is similar to the riverine areas, except that some typical bottomland species, such as river birch, willows, buttonbush, and shadbush drop out of the community, while other species, such as basswood, hawthorne, hazelnut, red maple, and several species of oaks begin to appear.

(3) Site-type III (Slopes): This is the most variable of the site-types with relation to species composition and productivity. The soils of this type generally have light colored cherty surfaces and red cherty clay subsoils. They are well drained but have limited water storage capacity due to the chert content and underlying clayey materials. These slopes are generally utilized for either woodland or pasture. Productivity varies over a considerable range and is dependent upon soils, aspect, and position on slope, and ranges from low to medium. Species composition also varies with changes in soil type, aspect, and slope position: oaks, hickories, ash, persimmon, red cedar, and occasional sugar maple. Dogwoods, hazelnut, possum haw, redbud, crabapples, serviceberry sumacs and buckhorn represent some of the more dominant understory species.

(4) Site-type IV (Uplands and Ridges): These sites are located on upland soils which are moderately well drained and which have a fragipan below th subsoil. They have a moderately low water storage capacity and are rather droughty sites and usually low in productivity. Some areas are used for pasture, but most of these sites support forest stands with a rather high percentage of white oak. Other species found on these sites include hickories, dogwoods, crabapples, persimmon, and sassafras. Some stands are composed almost solely of white oak. Trees are generally short-boled and productivity is low; however, the quality of mature trees is frequently fairly high.

c. Utilization: Although most forest stands in the Union Lake area have been subjected to moderate to heavy grazing pressure, there has been little incidence of burning as a management problem. Most of the stands have been cutover for walnut veneer logs, railroad tie cuts, and mine props.

2.2.1.3 Animals

a. Invertebrates:

(1) General: Invertebrates comprise the largest group of animals in the Meramec Basin in terms of species and biomass. The size and complexity and a lack of technical information on the group preclude intelligent discussion of the impact of water resource development on all species. Consequently, discussion is limited to species common in aquatic ecosystems, species considered rare, or species of significance from a public health standpoint. Elements of this are [illegible] in [illegible], Stream Communities, [illegible], [illegible] Species, and below.

(2) Molluscs: The Meramec Basin has an important Molluscan fauna. The bivalve molluscs (Pelecypoda) are represented by three families: Unionidae, Margaritanidae and Sphaeriidae. This represents the most diverse population of freshwater mussels in Missouri (Oesch, 1972; Ryckman, et al., 1973).

Forty-nine species of Unionidae have been identified from the Meramec Basin, including 43 species from the Bourbeuse River. The family Margaritanidae is represented only by the species, Cumberlandia Monondonta while the family Sphaeriidae is represented by the genera Sphaerium and Pisidium. In some areas of the Basin these two genera can be found in considerable numbers (Fuchs, 1971; Missouri Water Pollution Board, 1964). Six species of bivalve molluscs found in the project area are considered to be rare or endangered in Missouri; three species are being considered for a proposed Federal list of rare molluscs.

The univalve molluscs (Gastropoda) are represented by seven families in the Meramec Basin. The Viviparidae and Pleuroceridae are extremely common in certain areas. Other families include Physidae, Lymnaeidae, Planorbidae, Ancylidae and Amnicolidae (Fuchs, 1971; Missouri Water Pollution Board, 1964).

b. Vertebrates.

(1) Fishes: One hundred and nine species of fish are recorded from the Meramec Basin, including 83 species from the Bourbeuse drainage. One species, the pallid shiner, found in the Bourbeuse River is considered rare or endangered in Missouri. This species is not considered rare or endangered on a national basis.

Fish form the major vertebrate components of aquatic communities in the Meramec Basin and, as such, they are major consumers in the aquatic food chain. The Basin's streams support a sports fishery comprised of approximately 39 species, the most significant of which are longear and green sunfish, bluegill, smallmouth and largemouth bass, rock bass, black and yellow bullheads, and several species of suckers. Sport fish species are discussed in 2.2.5. There is no commercial fishery in the Basin.

(2) Amphibians: The Meramec Basin is known to provide habitat for [illegible] species of amphibians. Although all species have not been recorded in the project area, adequate habitat does exist and further field studies will reasonably be expected to establish their existence in the area. [illegible] of these species, the four-toed salamander, the grotto salamander, and the wood frog are considered rare, endangered, or of undetermined status by the Missouri Department of Conservation. Commonly observed species include the green, bull, leopard, and cricket frogs and the American and Fowler's toads.

Bullfrogs are a game species in the State of Missouri and, although detailed harvest data is unavailable, that species must be considered important from a recreational standpoint. Frogs are an important visual

and auditory component of the outdoor experience. In addition, frogs and salamanders serve as carnivores in the food chain and, in turn, are themselves eaten by several vertebrate species.

(3) Reptiles: Forty-seven species of reptiles are recorded from the Meramec Basin; of this number approximately 27 species are common components of the biological community. Only two species, the alligator snapping turtle and the scarlet snake, are sufficiently uncommon to be considered rare by the Missouri Department of Conservation.

Most of the reptiles in the Basin are carnivores and many play an important role in providing some control over small mammal populations. In turn, many of these reptiles are important in the diets of birds, mammals, and other reptiles. No species in the Meramec is considered to have commercial or recreational values, although some of the turtle species are caught and eaten locally. Many persons are fascinated by snakes and lizards, and they must be considered a legitimate part of the outdoor experience. Three species of poisonous snakes, the northern copperhead, the western pigmy rattlesnake, and the timber rattlesnake, are known from the Basin, but are not considered a substantial threat to human inhabitants. Commonly observed reptiles include the three-toed box turtle, the red-eared turtle, the northern fence lizard, the eastern garter snake, and the northern water snake.

(4) Birds: The Meramec Basin contains a rich and diverse avian fauna, consisting of at least 288 species. Commonly observed species include the green heron, wood duck, red tailed hawk, sparrow hawk, bobwhite quail, mourning dove, common night hawk, chimney swift, yellow shafted flicker, redheaded woodpecker, eastern kingbird, blue jay, common crow, mockingbird, robin, starling, house sparrow, cardinal, and indigo bunting. Twenty-six of the 288 known from the Basin are considered rare, endangered, or of undetermined status by the Missouri Department of Conservation and are discussed in further detail in 2.2.7.

The birds of the Basin provide a means of recreation through both hunting and observation. The principal game species are the bobwhite, wild turkey, and mourning dove (See 2.2.6). The bird resource is also utilized and enjoyed by both the dedicated birder, and the casual observer who encounters birds while pursuing other outdoor recreational activities. Ecologically, the birds of the Basin serve several important functions, including partial control if insect and mammalian populations and seed dispersal. Many species are consumed by reptiles, other birds, and mammals.

(5) Mammals: The Meramec Basin includes a mammalian fauna of 53 species. Fox squirrels, gray squirrels, cottontail rabbits, woodchucks, whitetail deer, raccoon and opossum are commonly seen in the Basin. Ten of the mammalian species found in the Meramec Basin are considered rare, endangered, or of undetermined status by the Missouri Department of Conservation. One, the Indiana bat, is now considered endangered on a national basis (See 2.2.7).

The esthetic and educational values realized by the general public through the observation of wild mammals is recognized. Their greatest ecological importance is their influence on vegetative communities through browsing and dispersal of seeds, control of insect populations, as contributors and consumers in food cycles, and in the transmission of disease.

2.2.2 SPRING COMMUNITIES

2.2.2.1 Physical Characteristics

Of 165 Missouri springs which have minimum flow of 1 cubic foot per second (Harvey and Vineyard, 1967), only three springs of this size are located in the Union Lake area. The largest, Kratz Spring, is located in the valley of Spring Creek (See Figures 4 and 5).

The discharge rate of the springs vary with periods of high and low runoff. Water quality of these springs is generally good. The spring water has a fairly uniform mineral content with calcium, magnesium, and bicarbonate as the major constituents. The Basin spring water has a relatively low suspended solids content with values ranging from 116 to 338 mg/L. From the biological standpoint, the most important characteristics of the spring water are high levels of dissolved oxygen and uniform low temperature (Ryckman, et al., 1973).

2.2.2.2 Plankton

A truly subterranean stream would contain no phytoplankton due to the lack of light.

2.2.2.3 Aquatic Plants

The following list of aquatic plants includes the most common species found in springs, or those characteristic of Ozark springs:

Eleocharis acicularis (L.) R. & S.
Poa annua L.
Sparganium americanum Nutt.
Potamogeton amplifolius Tuckerm.
Potamogeton Lucen L.
Zannichellia palustris L.
Anacharis occidentalis (Pursh) Victorin
Ceratophyllum demersum L.
Rorippa nasturtium - aquaticum (L.) Schinz & Thell.
Callitriche heterophylla Pursh
Ludwigia palustris (L.) Ell.
Myriophyllum heterophyllum Michx.
Veronica connata Raf.
Polygonun hydropiperoides Michx.
Cardamine bulbosa f. fontinalis Palmer & Steyermark

Of these 15 species, the three commonly found are water milfoil (Myriophyllum heterophyllum), water cress (Rorippa nasturtium - aquaticum), and water starwort (Callitriche heterophylla) (Steyermark, 1941).

2.2.2.4 Benthic Invertebrates

The benthic fauna of Missouri springs is augmented at the spring source by species otherwise known only from subterranean waters. As discussed below, these species are members of the same taxonomic groups that are dominant in the surface waters of springs (Pflieger, 1972).

All springs exhibit a high degree of benthic fauna similarity. The invertebrate fauna of the springs is characterized by few species and large numbers of individuals of certain groups. The Missouri spring fauna exhibits a high degree of endemism in that some species are known from only a single spring. This is probably due to genetic isolation from other invertebrate populations. The spring environment and its fauna is characterized by great stability. Temperature is probably the most important factor in limiting the distribution of organisms that comprise the spring fauna (Pflieger, 1972).

Flatworms, amphipods, isopods, snails, and certain insects are the dominant invertebrates in the Basin springs. Flatworms (Turbellaria) are among the most common and characteristic of the spring invertebrates. Amphipods and gastropods (snails) are exceedingly abundant in many springs. Insects are less numerous than other invertebrate groups in springs, with caddisflies (Tricoptera) being the most common insect group in Missouri springs (Pflieger, 1972).

2.2.2.5 Aquatic Vertebrates

Fishes and amphibians are the principal vertebrates in Missouri springs. The cave salamander and the hellbender inhabit many of the springs in the Basin. The only frog that is common in Basin springs is the pickerel frog (Ryckman, et al., 1973).

The fish fauna of the Basin springs is very limited. The two most characteristic and widespread species in springs and spring-fed streams are the mottled sculpin and banded sculpin. Other common species in spring habitats are the redbelly dace, creek chub, and white sucker (Ryckman, et al., 1973).

2.2.3 STREAM COMMUNITIES

2.2.3.1 Physical Characteristics

The Bourbeuse River is a typical Ozark Border stream, located in an area of transition between the Ozark highland and the prairies. The land is hilly and forested, with cultivated fields and pastures common. Stream gradients are moderate (as shown in Table 2) and the greatest portion of the Bourbeuse River mainstem within the Union Lake site is of a relatively low gradient (1.7 to 2.1 feet/mile). Table 3 summarizes the flowing water resources of the area.

Table 2 Gradients of the Bourbeuse River.

River Reach		Gradient*	Total Miles of Each Gradient
0 - 27.7	Mouth to Happy Fork Creek	2.1	27.7
27.7 - 55.2	Noser Mill	2.3	27.5
55.2 - 84.2	Bartel Bend	1.7	29.0
84.2 - 107.6	Highway 19	3.9	23.4

*Feet of fall per 100 feet.

Source: Hawksley, 1973.

Table 3. Flowing water resources of the Union Lake study area.

Streams	Drainage area (sq. mi.)	Length (miles)		
		Channel	Permanent flow	Intermittent pools
Bourbeuse River (Phelps-Franklin)	808	106½	106	11½
Union	767			
Birch Creek (Franklin)				4
Hamilton Creek (Franklin)			4	1
Lateral (Franklin)				½
Bachelor Creek (Franklin)				1
Voss Creek (Franklin)				½
Lateral (Franklin)				½
Spring Creek (Franklin)	52	18	3	3½
Big Creek (Franklin)				3
Boone Creek (Crawford)	50	14	2½	9½
Little Boone Creek (Franklin)				1½
Red Oak Creek (Gasconade-Franklin)	65	20	5½	8
Kriete Creek (Franklin)				½
Soap Creek (Gasconade)				½
Little Bourbeuse River (Crawford-Franklin)	59	18	11	3
Lateral (Crawford-Franklin)				2½
Lateral (Crawford)				1
Lateral (Crawford)				½
Lateral (Crawford)				1
Lateral (Crawford)				1
Lateral (Crawford)				2
Dry Fork Creek (Maries-Gasconade)			11½	13
Brush Creek (Gasconade)				1
Lateral (Gasconade)				½
Lower Peavine Creek (Maries)				2
Upper Peavine Creek (Maries)				½

Table 3. (Continued)

Streams	Drainage area (sq. mi.)	Length (miles) Chan-nel	Per-manent flow	Inter-mittent pools
Brush Creek (Crawford-Gasconade)	76	22	15½	3
Lateral (Crawford)				1
Lateral (Crawford)				½
Lateral (Crawford)				1½
Prairie Valley Creek (Crawford)			2½	1½
McDade Spring Lateral (Crawford)			1	1½
Lateral (Crawford)				½
Lateral (Crawford)				½
Relsobel Branch (Gasconade)				½
Price Creek (Gasconade)				2
Lane Fork (Maries-Phelps)				11½
Pinoak Creek (Maries)				½
Bailey Creek (Maries)				½
Clear Creek (Phelps)				2
Total Bourbeuse River Drainage			163	101

Source: Ryckman, et al, 1973.

The series of alternating pools and riffles found in the Bourbeuse River and its tributaries (See Figures 6 and 7) are typical of streams that have not reached base-level conditions. Substrate in the streams also alternate between silt in pools and gravel bottoms in the riffles (see Table 4 and Plate 9). Also as in most streams, progressing downstream, the pools become proportionately longer and deeper. The Bourbeuse River is moderately clear but it clears rather slowly after rains. Water quality of the river is generally good, with isolated areas affected by domestic and agricultural pollution.

2.2.3.2 Aquatic Flora

a. Plankton. Most running water contains free-floating organisms, and in large rivers or sluggish streams, many of these are truly planktonic. Plankton is much less important in a stream's economy compared with its dominant position in lake ecosystems. In rivers, phytoplankton is always more abundant than zooplankton, and diatoms are usually the dominant group in the phytoplankton, while rotifers are usually the most abundant organisms in the zooplankton. The headwaters probably contain no true plankton, rather an assemblage of detached and drifting organisms. Cymbella sp., Navicula sp., and Cocconeis sp. are probably the dominant diatoms. Other species of detached and drifting algae were Synbra sp., Diatoma sp., Cyclotella sp., Gomphonema sp., Surirella sp., and Cymatopleura sp. These drift organisms are a very important source of food for benthic invertebrates and some fishes. The lower Bourbeuse River, because of its slow moving current and large pools, probably contains some true planktonic organisms.

b. Vascular Plants. Knowledge of the aquatic vegetation of the Missouri Ozarks is limited. Steyermark (1963) states that the characteristic aquatic plants of Ozark streams are Potamogeton nodosus, Vallisneria americana, Heteranthera dubia, and Nuphar luteum var. ozarkanum. Other aquatic plants likely to be found are as follows:

Ceratophyllum demersum
Sparganium americanum
Myriophyllum hetterophyllum
Justicia americana
Anacharis nuttillii
Potamogeton diversifolius
Veronica comosa
Poa annua var. reptans
Callitriche heterophylla
Equisetum hyemale
Sagittatia latifolia
Ranunculus longirostris

2.2.3.3 Aquatic Invertebrates

a. General: The aquatic invertebrates of the Bourbeuse River are generally representative of unpolluted running water with high dissolved oxygen concentrations. A list of these invertebrates is found in Table 5.

Table 4. Bottom type and riffle - pool development in the Bourbeuse River.

Sampling Location No.	Description	Bottom Type (%) Silt	Sand	Rubble	Gravel	Boulders
1.	Very long, deep pools; broad undefined riffles	20	10	20	30	20
2.	Large pools; long riffles	20	10	20	50	
3.	Very long, deep pools; narrow riffles	40		10	40	10
4.	Very long, deep pools; long broad riffles		20	30	[illegible]	
5.	Long, deep pools; long, narrow riffles	[illegible]			[illegible]	
6.	Long, deep pools; long, narrow riffles	[illegible]				[illegible]
7.	Large pool caused by low-water dam; long riffles	[illegible]				
8.	Long deep pools; very long narrow riffles					
9.	Long, deep pools; short, narrow riffles					
10	Long, narrow pools; long, narrow riffles; backwater pool					
11.	Long, deep pool; short, shallow, narrow riffle					
12.	Deep pool; long, wide riffle	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13.	Large, shallow pools; wide riffles	10	[illegible]	[illegible]	[illegible]	
14.	Long, shallow pools; short riffles	[illegible]	[illegible]	10	[illegible]	
15.	Long, deep pools; short, narrow riffles	10	[illegible]	10	[illegible]	10
16.	Short pools; long, narrow riffles	5	20	[illegible]	60	10

Source: Fyckman, et al., [illegible].

Table 5 Species and Number of Aquatic Invertebrates Collected from the Bourbeuse River, Using Surber Stream Bottom Sampler, from Three Square Feet of Substrate.

	Number of Individuals									
Station Number *	1			6		7	8	9		16
Date Collected	25 Jun 73	29 Jun 73	14 Aug 73	26 Jun 73	14 Aug 73	14 Aug 73	14 Aug 73	2 Jul 73	14 Aug 73	26 Jun 73
Annelida										
Hirudinea										
Rhynchobdellida										
Glossiphoniidae										
Helobdella	1						1			
Oligochaeta										
Plesiopora										
Tubificidae	2	2		1		3	1		1	
Porifera										
Mollusk										
Gastropoda										
Amnicolidae							1			
Ancylidae										
Ancylas				1						
Ferrissia			2		2					
Pelecypoda										
Sphaeriidae										
Sphaerium				1						
Musculium					2		1			
Insecta										
Ephemeroptera (Mayflies)										
Baetidae										
Ephemerella	1									
Baetis		6	5		1	1			[illegible]	
Isonychia	12	11	23		5	6	3		[illegible]	
Tricorythodes		8	172		20	1	13	7	[illegible]	
Paraleptophelbia							5			
Caenis								4		
Centroptilum									1	
Heptageniidae										
Stenonema	7	22	22		16	1	4	20	[illegible]	1
Heptagenia	3	15			6		3	3	2	

*See Plate 9 for locations of stations

Table 5. (Continued)

Station Number	1			2						
Date Collected	25 Jun 73	29 Jun 73	14 Aug 73	2? Jun 73	1? Aug 73	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Number of Individuals										
Insecta (Cont'd)										
Ephemeroptera (Mayflies)										
Ephemeridae										
Ephoron	12	14			3			[illegible]		
Diptera (Flies, Mosquitoes, Midges)										
Simulidae										
Simulium venustam						2				2
larva	7		8							2
pupa		3	5							
Tendipedidae							1	2	4	14
Tendipes larva	1	3	31		2		3	1	2	
pupa									1	
adult										
Pentaneura monilis			1							
Diamesinae										
Dixidae										
Dixa				1						
Ceratopogonidae										
Dasybelea									1	
Tipulidae										
Heptoma						1				
Hexatoma									1	
Rhagionidae										
Atherix										
Trichoptera (Caddisflies)										
Hydropsychidae										
Hydropsyche simulan	15	14	141	20	9	4	35	5	21	1
Rhyacophilidae										
Rhyacophila			1			1	4		2	
Hydroptilidae										
Hydroptila waubesiana			3							
Coleoptera (Beetles)										
Elmidae										
Stenelmis larva	11	16	7		10	17	4	10	19	
adult	?	4	26		94	6	2	5	1	
Gyrinidae										
Dinentus	1									

Table 5 (Continued)

Station Number	1			6		7	8	9		16
Date Collected	25 Jun 73	29 Jun 73	14 Aug 73	26 Jun 73	14 Aug 73	14 Aug 73	14 Aug 73	2 Jul 73	14 Aug 73	26 Jun 73
	Number of Individuals									
Insecta (Cont'd)										
Coleoptera (Beetles)										
Pytiscidae										
Laccophilus		1								
Dryopidae										
Dryops			4						2	
Hemiptera										
Nepidae										
Ranatra								1		
Odonata (Dragonflies, Damselflies)										
Zygoptera										
Coenagrionidae										
Nehalennia								1		
Argia									1	
Anisoptera										
Gomphidae										
Hagenias brevistylus							1			
Progomphus								1		
Plecoptera (Stoneflies)										
Perlidae										
Neoperla clymene		2	1		6	5	1	1	2	
Pteronarella				9						
Paragnetina						1				
Megaloptera										
Corydalidae										
Chauliodes			3		1		1			
Sialis				12						
Corydalus cornutus		1	26		1					
Crustacea										
Amphipoda										
Gammaridae										
Gammarus fasciatus		1								
Individuals	74	124	482	45	178	49	84	77	98	20
Species	13	16	18	7	15	13	18	14	19	5
Species Diversity*	2.79	3.11	2.75	1.58	2.70	3.08	3.84	2.99	1.93	1.34

*Margalef (1958)

[illegible] greatly determined by the type of sub- [illegible] riffles offer favorable surfaces for [illegible] animals) to attach or cling. The soft, [illegible] areas generally limits smaller benthic [illegible]

[illegible] Dominant benthic invertebrates are aquatic [illegible] The following insect orders are commonly found [illegible]:

Ephemeroptera (Mayflies)
Plecoptera (Stoneflies)
Odonata (Dragonflies, Damselflies)
Trichoptera (Caddisflies)
Coleoptera (Beetles)
Diptera (Flies, Mosquitoes, Midges)
Megaloptera (Alderflies, Dobsonflies, Fishflies)

Ephemeroptera (Mayflies) makes up the majority of the bottom fauna. During the spring, the general community type of Ozark streams consisted of Ephemerella and Tricorythodes. During the summer, the community type consists of Stenonema, Tricorythodes, and larvae of Opthioservus and Ectopria (water penny beetle).

c. Crustacea. Isopoda, Amphipoda, and Decapoda are some of the common orders of Crustaceans in the Bourbeuse River. Others that probably inhabit the area are Cladocera, Copepoda, and Ostracoda.

d. Mollusca. Very little information is available on the Gastropods (snails) of the Bourbeuse River area. The aquatic snails have been identified only to genus or to family (see Table 6). Seven families are represented in the area and the Viviparidae and Pleuroceridae are extremely common in certain areas. Other families include Physidae, Lymnaeidae, Planorbidae, Ancylidae, and Amnicolidae (Fuchs, 1971; Missouri Water Pollution Board, 1966). Species lists of pelecypods (clams, mussels) are given in Tables 6 and 7. Collection locations are shown on Plate 10. Species diversity does not vary within the study area, but there is a greater proportion of headwater types in the Union Lake study area than further downstream in the Bourbeuse River. The bivalve molluscs are represented by three families; Unionidae, Margaritanidae, and Sphaeriidae. This represents the most diverse population of freshwater mussels in Missouri (Oesch, 1972; Buckman, et al., 1973).

Forty-three species of Unionidae have been identified from the Bourbeuse River. The family Margaritanidae is represented only by the species Cumberlandia monondonta, while the family Sphaeriidae is represented by the genera Sphaerium and Pisidum. In some areas of the Basin these two genera can be found in considerable numbers (Fuchs, 1971; Missouri Water Pollution Board, 1964). Six species of bivalve molluscs are considered to be rare or endangered in Missouri; four species are being considered for a proposed Federal list.

e. Others. Other invertebrate goups include Protoza, Rotatoria, Nematoda, Nematomorpha, Bryozoa, Annelida (Oligochaeta and Hirudinea), and Porifera.

Table 6. Partial list of aquatic Mollusca of the Meramec Basin

PHYLUM MOLLUSCA

Class Gastropoda
  Order Ctenobranchiata (Snails)
    Family Viviparidae
        Campeloma sp.
        Viviparus sp.

    Family Pleuroceridae
        Pleurocera sp.
      * Goniobasis potosiensis

    Family Amnicolidae
     ** Amnicola procerpina
        Somatogyrus sp.
     ** Amnicola aldrichi antroecetes

    Family Bulimidae
      * Fontigens aldrichi
      * Fontigens antrocoetes
      * Fontigens proserpina

  Order Pulmonata (Snails)
    Family Physidae
        Physa sp.

    Family Lymnaeidae
        Lymnaea sp.
        Bulimnaea sp.
        Stagnicola sp.

    Family Ancylidae
        Ferrissia sp.

    Family Planorbidae

Class Pelecypoda
  Order Unionidia (Clams, Mussels)
    Family Sphaeriidae
        Pisidium sp.
        Sphaerium sp.

    Family Margaritanidae
        Cumberlandia monodonta

    Family Unionidae
      Subfamily Anodontinae
        Alasmidonta calceolus
        Alasmidonta marginata
        Micromya brevicauda
        Strophitus undulatus
        Anodonta imbecilis
        Anodonta grandis

Table 6. [illegible] aquatic Mollusca of the Meramec Basin

Arcidens confragosus
Lasmigona complanata
Lasmigona costata

Subfamily [illegible]
Tritogonia verrucosa
Fusconaia flava f. flava
Fusconaia flava f. trigona
Quadrula metanevra
Quadrula pustulosa
Quadrula quadrula
Megalonaias gigantea
Amblema plicata
Cyclonaias tuberculata
Plethobasus cyphyus
Pleurobema coccineum f. coccineum
Pleurobema coccineum f. catillus
Pleurobema coccineum solida
Elliptio crassidens
Elliptio dilatatus

Subfamily Lampsilinae
Obliquaria reflexa
Leptodea fragilis
Leptodea leptodon
Plagiola lineolata
Truncilla donaciformis
Truncilla truncata
Dysnomia triquetra
Lampsilis anodontoides f. anodontoides
Lampsilis anodontoides f. fallaciosa
Lampsilis breviculа
Lampsilis higginsii
Lampsilis ovata f. ventricosa
Ligumia recta
Actinonaias ligamentina
Actinonaias ellipsiformis
Lampsilis radiata luteola
Potamilus alata
Potamilus laevissimus
Toxolasma glans
Toxolasma parva
Corbicula manillensis
Obovaria olivaria

*Species found in springs
**Species found in subterranean streams

Source: Clifford, 1966; Fuchs, 1971; Missouri Water Pollution Board, 1964.

[illegible] alphabetical listing species of bivalve molluscs (Pelecypoda) [illegible] collected in the Meramec Basin

[illegible]	Relative* Abundance	Collection Locations** I	II	III	IV	V	VI
Actinonaias ellipsiformis	P		x	x	x	x	x
Actinonaias ligamentina	C	x	x	x	x	x	x
Alasmidonta calceolus	R		x				
Alasmidonta marginata	F		x	x	x	x	x
Amblema plicata	U		x	x	x	x	x
Anodonta grandis	F	x	x	x	x		x
Anodonta imbecillis	R	x	x	x		x	x
Arcidens confragosus		x			x		x
[illegible] ...sis***					x		
[illegible] ...onta	U		x	x	x		x
[illegible] ...rculata	F		x	x	x		x
[illegible] ...a	R		x	x	x	x	x
[illegible] ...dens				x	x		x
[illegible] ...atatus	C		x	x	x	x	x
[illegible]							x
[illegible] f. flava			x	x	x	x	x
[illegible] ...ndata							x
[illegible] f. trigona	U	x	x	x	x		x
[illegible] ...des f. anodontoides		x	x	x	x		x
[illegible] ...des f. fallaciosa	U	x	x	x	x		x
[illegible] ...a	F	x	x	x	x		x
[illegible]	R	x	x	x	x		
[illegible] ventricosa	C		x	x	x	x	x
[illegible] luteola			x	x	x	x	x
[illegible] ...a		x	x	x	x	x	x
[illegible]	C		x	x	x		x
[illegible]	C		x	x	x	x	x
[illegible]	F		x	x	x	x	x
[illegible]	R		x	x	x	x	x
[illegible]	U		x		x		
[illegible]			x	x	x		x
[illegible]					x		
[illegible]			x	x	x	x	x
[illegible] ...us	R		x	x	x		x
[illegible] ...um f. coccineum	F		x	x	x	x	x
[illegible] ...um f. catillus		x	x	x	x		x
[illegible] ...ida	R		x	x	x		x
[illegible]	C		x	x	x		x
[illegible] ...ma	F		x	x	x		x
[illegible] ...ndentales							x

Table 7. (Cont'd)

Species	Relative* Abundance	Collection Locations** I	II	III	IV	V	VI
Quadrula metanerva	F		x	x	x	x	x
Quadrula pustulosa	F		x	x	x	x	x
Quadrula quadrula		x	x	x	x		x
Strophitus undulatus			x	x	x	x	x
Toxolasma glans					x		
Toxolasma parva		x	x	x	x	x	x
Tritogonia verrucosa	F		x	x	x	x	x
Truncilla donaciformis	U		x	x	x		x
Truncilla truncata	R		x	x	x	x	x

* Relative abundance is given for certain species and refers to the populations of these species found upstream from Meramec State Park. Relative abundance is determined by frequency of shells collected (Oesch, 1973):

P = Plentiful   U = Unusual
C = Common   R = Rare
F = Frequent

** Collection locations (see Plate 17) are as follows:

*** Exotic Species

I - Meramec River between State Highway 8 and the Crawford - Phelps County line.

II - Meramec River between mile 155 downstream and State Highway 185.

III - Meramec River between State Highway 185 and Bourbeuse River.

IV - Meramec River between Bourbeuse River and Fenton, Missouri.

V - Bourbeuse River between Ryker's and Meramec River.

VI - Bourbeuse River between Rock Ford and Ryker's Ford.

NOTE: Most of collection area VI is in Union Lake.

Source: Oesch (1973); Ryckman et al. 1973).

2.2.3.4 Aquatic Vertebrates

Of the one hundred and nine species of fish recorded from the Meramec Basin, eighty-three species were recorded from the Bourbeuse River. Species recorded from the study area are shown in Tables 8, 9 and 9a. One species, the pallid shiner, is considered rare or endangered in Missouri. This species is not considered rare or endangered on a national basis.

Fish form the major vertebrate components of aquatic communities in the Meramec Basin and, as such, they are major consumers in the aquatic food chain. The basin's streams support a sport fishery comprised of approximately 39 species. There is no commercial fishery in the Basin.

Table [illegible] [illegible] collected in the Union Lake study area and downstream in the Bourbeuse River.

Species	STATIONS* 1	2	3	4	5
Gizzard shad	2	6	0	0	0
Goldeye	0	p	0	0	0
Grass pickerel	0	0	0	0	25
Golden shiner	0	0	0	2	0
Creek chub	0	0	11	0	0
Southern red-bell dace	0	0	19	0	0
Gravel chub	3	2	0	1	0
Silver chub	3	0	0	0	0
Suckermouth minnow	4	0	0	1	0
Emerald shiner	7	0	0	0	0
Rosyface shiner	17	2	0	4	0
Redfin shiner	0	0	0	7	38
Striped shiner	0	0	0	2	0
Bigeye shiner	0	24	0	118	9
Steelcolor shiner	52	52	0	50	0
Spotfin shiner	25	28	0	28	0
Sand shiner	9	0	19	0	0
Mimic shiner	0	0	0	0	0
Silverjaw minnow	0	0	1	0	0
Bullhead minnow	6	0	0	0	0
Bluntnose minnow	6	3	0	20	7
Stoneroller	32	8	64	5	0
Quillback	4	4	1	0	0
White sucker	0	0	6	0	0
Northern hog sucker	3	0	0	1	0
Black redhorse	5	1	0	2	0
Golden redhorse	3	1	0	0	7
Silver redhorse	0	0	0	6	0
Shorthead redhorse	2	3	0	0	0
River redhorse	1	3	0	0	0

Species	STATIONS* 1	2	3	4	5
Spotted sucker	0	0	0	0	0
Creek chubsucker	0	0	0	0	9
Black bullhead	0	0	0	0	2
Yellow bullhead	0	0	0	0	2
Channel catfish	0	0	0	1	0
Slender madtom	0	0	0	0	0
Stonecat	0	0	0	3	0
Northern studfish	1	1	4	0	0
Blackstripe topminnow	0	0	0	0	18
Smallmouth bass	4	1	0	5	0
Largemouth bass	0	1	11	0	9
Green sunfish	0	0	0	0	8
Orangespotted sunfish	0	1	0	1	29
Longear sunfish	14	9	0	8	0
Bluegill	0	1	0	1	29
Rock bass	0	0	0	0	0
Slenderhead darter	2	2	0	3	0
Gilt darter	0	2	0	11	0
Johnny darter	0	0	0	0	2
Missouri saddled darter	0	1	0	13	0
Banded darter	0	1	0	2	0
Greenside darter	1	1	0	16	0
Rainbow darter	0	0	0	3	0
Orangethroat darter	0	0	37	0	20
Fantail darter	0	0	0	1	0
Mottled sculpin	0	0	1	0	0
Brook silverside	0	2	0	10	6
Southern logperch	0	2	0	6	0
TOTAL NUMBER OF FISH	206	162	175	331	191
Total Number of Species	23	26	11	29	15

*Stations in the Union Lake Study Area, (see Plate 11).

p - Present, no estimate of numbers.

Source: Ryckman, et al, 1973.

TABLE 9

SOME LARGE FISHES
OF BOURBEUSE RIVER

Species	Number of Fish Collected, Summer 1972	
	Reiker's Ford	Noser's Mill Vicinity
Black redhorse	401	145
Shorthead redhorse		97
Spotted sucker	29	45
Northern hog sucker	56	Not abundant in sample
Carp	13	7
Channel catfish	27	42
Longear sunfish	334	244
Green sunfish	Not abundant in sample	38
Bluegill	37	35
Largemouth bass	51	59
Smallmouth bass	40	33
Rockbass (goggle-eye)	35	118

Source: [illegible]kman, *et al.*, 1973.

Table 9a. Fish collected from the Project Area by Corps Personnel, Summer 19[illegible]. (Sampling Stations shown in Plate 9)

Class Osteichthys	Sampling Station
Order Semionotiformes	
Lepisosteidae - Gars	
Lepisasteus osseus Longnose gar	9,10, 12
Order Clupeiformes	
Clupeidae - Herrings	
Dorosoma cepedianum Gizzard shad	3
Order Salmoniformes	
Esocidae - Pikes	
Esox americanus vermiculatus Grass pickerel	14
Order Cypriniformes	
Cyprinidae - Minnows and carps	
Campostoma anomalum Stoneroller	3,6,8,9,10,12,14,15,16
Hybopsis amblops Bigeye chub	14,15
Nocomis biguttatus Hornghead chub	16
Notemigonus crysoleucas Golden shiner	10
Notropis boops Bigeye shiner	3,6,8,9,10,12,14,15
Notropis chrysocephalus Striped shiner	3,8,9,10,14,15
Notropis galacturus Whitetail shiner	8
Notropis greenei Wedgespot shiner	3
Notropis spilopterus Spotfin shiner	3,6,9,10,12.14
Notropis stramineus Sand shiner	8,9,14,15,16
Notropis umbratilis Redfin shiner	3,6,8,9,10,12,14,15
Notropis volucellus Mimic shiner	3,8,9,10,12
Notropis whipplei Steelcolor shiner	3,9,10,12,14,15
Phoxinus erythrogaster Southern redbelly dace	16
Pimephales notatus Bluntnose minnow	3,6,8,9,10,12,14,15
Pimephales vigilax Bullhead minnow	8
Semotilus atromaculatus Creek chub	3,9,10,15
Catostomidae - Suckers	
Carpoides cyprinus Quillback	10
Erimyzon oblongus Creek chubsucker	15
Hypentelium nigricans Northern hog sucker	8,9,15
Moxostoma carinatum River redhorse	9
Moxostoma duquesnei Black redhorse	8,14
Moxostoma erythrurum Golden redhorse	9,10,14
Moxostoma macroleipidotum Shorthead redhorse	8

Order Siluriformes	
Ictaluridae - Freshwater catfishes	
Ictalurus melas Black bullhead	10
Ictalurus natalis Yellow bullhead	10,14,15
Notorus exilis Slender madtom	3,10
Cyprinodonfidae - Killfishes	
Fundulus catenatus Northern studfish	3,8,9,15,16
Fundulus notatus Blackstripe topminnow	3,6,8,9,10,14,15
Poeciliidae	
Cambusia affinis Mosquitofish	8,10
Order Atueriniformes	
Centrarchidae - Sunfishes	
Ambloplites rupestris Rock Bass	9,10,14
Lepomis cyanellus Green sunfish	10,14,15
Lepomis himilis Orangespotted sunfish	3,6,10,12,15
Lepomis macrochirus Bluegill	3,9,10,14,15
Lepomis megalotis Longear sunfish	3,6,8,9,14,15
Micropterus dolomieui Smallmouth bass	8,9,10,14,15
Micropterus salmoides Largemouth bass	3,8,9,10,14,15
Percidae - Perches	
Etheosfoma blennioides Greenside darter	3,8,14
Etheosfoma caeruleim Rainbow darter	3
Etheosfoma flabellare Fantail darter	9
Etheosfoma nigrum Johnny darter	6,10,14
Etheosfoma spectabile Orangethroat darter	3,15,16
Etheosfoma zonale Banded darter	8,10,12,16
Percina caprodes Logperch	8,14
Percina phoxocephala Slenderhead darter	8
Cottidae - Sculpins	
Cottus carolinae Banded sculpin	16

2.2.4 CAVE COMMUNITIES

2.2.4.1 General

The cave environment can be separated into a twilight zone near the entrance, an intermediate zone of complete darkness and variable temperature, and a zone in the deep interior with complete darkness and constant temperature. Caves make ideal natural laboratories because of the simplicity of their biological communities and the stability of the physical environment (Poulson, 1969).

2.2.4.2 Union Lake Area

The Meramec Basin has a great many caves, however, most of them are south of the Bourbeuse Valley. Weber Quarry Cave is the only "living" cave (a cave that is still being formed by solution activity) that has been located in the project area. The cave is only about 100 to 200 feet long and has no dark zone. No troglobitic life was found.

2.2.5 SPORT FISH RESOURCES

2.2.5.1 General

At least 29 species of fish that are grouped under the very broad term "sport fish" have been recorded from the Bourbeuse River. They are listed in Table 10. Another 10 species have been recorded from the Meramec Basin and thus have reasonable access to the Bourbeuse River. These are listed in Table 11. Thus, approximately 39 species of "sport fish" are potential inhabitants of the Bourbeuse River.

Table 10. Sport fish species recorded from the Bourbeuse River

Rainbow trout	Channel catfish
Grass pickerel	Flathead catfish
Carp	Rock bass
Quillback	Green sunfish
White sucker	Orangespotted sunfish
Northern hog sucker	Bluegill
Black buffalo	Longear sunfish
Spotted sucker	Smallmouth bass
Silver redhorse	Largemouth bass
River redhorse	White crappie
Black redhorse	Black crappie
Golden redhorse	Sauger
Shorthead redhorse	Walleye
Black bullhead	Freshwater drum
Yellow bullhead	

Table 11. Sport fish species inhabiting the Meramec Basin but not recorded from the Bourbeuse River.

Paddlefish	Bigmouth buffalo
Bowfin	White bass
River carpsucker	Pumpkinseed
Blue sucker	Warmouth
Smallmouth buffalo	Redear sunfish

No quantitative harvest data is available for the Bourbeuse River. However, an intensive ten-year creel census of Huzzah and Courtois Creek, tributaries of the Meramec River (Fleener, 1971) showed that five centrachids, the longear sunfish, rock bass, smallmouth bass, green sunfish, and bluegill, in that order, comprised 87 percent of the sport catch. Suckers, rainbow trout, largemouth bass, and bullheads were other fishes comprising more than one percent of the catch. Other game species found in the Basin but not recorded in the creel census data include the paddlefish, grass pickerel, pumpkinseed, warmouth, orangespotted sunfish, redear sunfish, and saufer. Although there are significant differences in habitat types between the Huzzah and Courtois Creeks and the Bourbeuse River, there is enough similarity that it can be assumed with some degree of certainty that this is generally indicative of the sport fishery of the Bourbeuse River, although the relative importance of certain species may differ.

The only available data pertaining to fishing pressure and fishermen success was gathered by Funk (1969) over a 13-year period, 1946-58, and is presented in Table 12. The data for 1946 was deleted because Funk considered it to be "less reliable than that for subsequent years".

Table 12. Fishing pressure and fishermen success, Bourbeuse River and Meramec Basin, 1947-58. (Figures are annual averages)

	Fishermen Checked	Man hours fished	Fish Caught	Fish Hour	Percent Successful Fisherman	Percent Boat Fisherman
Big River	205	653	307	0.51	44	22
Lower Meramec	99	360	114	0.32	48	26
Middle Meramec	176	620	304	0.50	52	37
Upper Meramec	225	627	639	1.10	65	23
Basin Total (Incl. Bourbeuse)	164	520	319	0.63	53	25
Bourbeuse River	116	340	232	0.72	58	19

2.2.5.2 Important Game Species

Although approximately 39 species fitting the general description "game fish" may inhabit the Bourbeuse River, most are insignificant in the total game fish harvest. A brief description of the more important species is given below.

The longear sunfish is one of the most abundant fishes in the Meramec Basin and probably the most frequently caught fish in the Basin as well. The longear prefers pools, backwaters, and other protected areas of clear, permanent streams. In streams it is most often found over a bottom of sand, gravel, or rubble. The longear also thrives in many large Ozark impoundments.

In Missouri, the rock bass appears to prefer a stream habitat, being only a minor species in reservoirs. It is found in a variety of habitats although it avoids areas with strong flow. It is often found near logs, large rocks, beds of vegetation, and other cover.

The smallmouth bass is the "glamour" fish of the Meramec Basin. It ranks high in total catch throughout the entire Basin. It was the fifth most abundant fish in Huzzah and Courtois Creeks (Fajen, 1972) and the predominant predator species, and probably is equally important in the Bourbeuse River. The smallmouth bass is primarily a stream species in the southern part of its range, although it does well in many lakes and some impoundments.

The green sunfish ranks second throughout the whole Basin in the sport catch and first in the Bourbeuse River (Funk, 1969), and probably constitutes a more substantial part of the standing crop. Green sunfish occur in a wide variety of habitats and tolerate a wide range of environmental conditions. It is often quite abundant in muddy ditches, ponds, streams, and also does well in large impoundments.

The bluegill is the third-ranking sport fish throughout the whole Basin and the second ranking sport fish in the Bourbeuse River (Funk, 1969), and probably comprises a substantial part of the standing crop. It prefers quiet waters, over-flow areas, and sloughs in the stream environment. It reaches its peak in reservoirs where it is often the most abundant centrarchid.

Suckers are essentially stream fishes and are generally found in or near riffles, pools, and in some cases, in the swift water of the main channel. Although a minor group in the Bourbeuse River creel census, they are common throughout the Meramec Basin (Funk, 1969).

Largemouth bass prefer quiet waters such as oxbows, sloughs, and overflow pools along rivers, and they do especially well in reserveirs. They represent a rather small percentage of the total catch in the Bourbeuse River (Funk, 1969).

Bullheads, two species, the black and yellow bullheads, occur in the Basin. They are often found in streams, but generally prefer quiet, often muddy waters. They are often quite abundant where they occur and do well in reservoirs, especially during the initial years of impoundment.

2.2.5.3 Summary

The Bourbeuse River supports a substantial and quite diverse sport fishery and receives heavy fishing pressure as do all of the streams in the Meramec Basin. The fish caught per hour and percent of successful fishermen using the Bourbeuse River are similar to the average figures for all streams of the Ozark Border Area (Funk, 1969). Centrarchids (smallmouth bass, rock bass, green sunfish, longear sunfish, and bluegill), suckers (mainly redhorse), and catfish predominate in the sport catch.

2.2.6 GAME RESOURCES

The Meramec Basin provides important habitat for almost all animals considered game species in the State of Missouri. The principal game species in the Basin include white-tailed deer, cottontail rabbit, gray squirrel, fox squirrel, woodchuck, bobwhite quail, mourning dove, wild turkey, woodcock, common snipe, crows, and a variety of waterfowl. Important furbearers include raccoon, muskrat, opossum, mink, coyote, beaver, and to a lesser extent, gray fox, red fox, striped skunk, spotted skunk, bobcat, badger, and weasel.

In general, prime habitat in the Meramec Basin for the species listed above includes a mixture of hardwood forest and cropland. The productivity of these habitats reflects the quality and fertility of the soil on which they are found. Consequently, although many of the game species known from the Basin may be found throughout the area, the most important habitat occurs in the fertile alluvial soils of the bottomland areas. The most productive bottomland situation is one in which the mature forest is broken by small agricultural fields (see Figures 8 and 9). Table 13 shows the population densities for selected game species in the Union Lake project area.

Table 13. Estimated population density for selected game species in the Union Lake area.

Species	Estimated Population Density*
White-tailed deer	15 per square mile
Fox and gray squirrel	2 per acre
Cottontail rabbit	1 per 10 acres
Bobwhite	1 per 3 acres
Wild turkey	5 per square mile

*Estimates made by the Missouri Department of Conservation (1972).

White-tailed deer are most common in the more heavily forested western and southern portions of the Basin; the project area provides good deer habitat in the river bottoms where there is interspersion between cropland and forest.

Fox squirrels perfer open timbered areas, while gray squirrels are most common in areas of heavy timber. Both types of squirrels do best in areas with mature to over-mature trees. More squirrels are harvested in the Meramec Basin than any other game species.

The best cottontail rabbit habitat in the Basin occurs in the Bourbeuse drainage, which includes the Union Lake project, where there is interspersion of brush, forest, and cropland. The cottontail is the second most popular game animal in terms of numbers taken.

Franklin County is one of the top fur harvest counties in Missouri and had the greatest fur harvest in the Basin in 1971-72 season. Raccoon and muskrat are the most important furbearers in the project area. The muskrat is associated with the rivers, ponds, and streams of the project area; raccoons are generally found near water where hardwood stands are present to provide den cavities.

The bobwhite is most abundant in the Bourbeuse drainage of the Basin where the agricultural lands provide the annual plants that quail require for food. On the project area, this habitat would occur primarily in the agricultural bottoms.

The mourning dove is numerous in the open farmland of the Bourbeuse valley, where agricultural crops are available for food. In the project area they primarily utilize agricultural lands.

Optimum turkey habitat in Missouri occurs on land that is approximately 70 percent timbered and 30 percent open. Although the best turkey range in the Meramec Basin is south of Franklin County, some excellent habitat occurs in the eastern portion of the Union Lake project area, where heavy timber is interspersed with bottomland cropland.

2.2.7 RARE AND ENDANGERED SPECIES IN THE MERAMEC BASIN

2.2.7.1 General

A number of rare and/or endangered plant and animal species occur or are believed to occur in the Meramec Basin. Although most are present in very limited numbers, all are considered to be valuable and important constituents of Missouri flora and fauna.

Vertebrates included in this discussion are those considered Rare or Endangered or of Unknown Status by the Missouri Department of Conservation (1972), and/or the U. S. Bureau of Sport Fisheries and Wildlife (1973). The invertebrates and plant species presented in this discussion are taken from a draft list prepared by the U. S. Soil Conservation Service in cooperation with the Missouri Department of Conservation. Only plant and animal species native to Missouri are included in this discussion.

2.2.7.2 Plants

Four species of liverworts, 16 species of mosses, and 8 species of pteridophytes that are considered rare in Missouri have been identified in counties that are in the Meramec Basin. Although these rare species have not been identified specifically from the project area, suitable habitat exists, and their occurrence in this area is possible.

Sixty-four species of spermatophytes, the largest group of green plants, that are considered rare or endangered have been reported from Basin counties and may occur in the project area.

2.2.7.3 Animals

a. Invertebrates: Invertebrates that have been identified as rare and endangered in the Meramec Basin include 3 species of crayfish, 3 species of millipeds, 1 species of grasshopper, 2 species of caddisflies, 1 species of beetle, 1 species of moth, and 6 species of mussels.

b. Vertebrates: Rare or endangered vertebrate species that have been reported from the Meramec Basin are listed below.

(1) Fish: Only one rare and endangered species of fish, the pallid shiner, has been recorded from the Bourbeuse River, and this was prior to 1945. The pallid shiner is considered endangered, perhaps extirpated, in Missouri.

(2) Amphibians: The four-toed salamander is considered rare in Missouri; the grotto salamander is considered to be status-undetermined in Missouri and nationally; and the wood frog is considered endangered in Missouri.

(3) Reptiles: The alligator snapping turtle and the scarlet snake are considered rare in Missouri.

(4) Birds: Thirteen species of rare or endangered birds that are either permanent winter or breeding residents of the Meramec Basin are listed below:

Species	Status
Sharp-skinned hawk	Endangered in Missouri
Cooper's hawk	Endangered in Missouri
Red-shouldered hawk	Rare in Missouri
Marsh hawk	Undetermined status in Missouri
Northern bald eagle	Rare in Missouri
King rail	Rare in Missouri
Common gallinule	Undetermined status in Missouri
Least tern	Rare in Missouri
Black-billed cuckoo	Undetermined status in Missouri
Barn owl	Rare in Missouri
Long-eared owl	Undetermined status in Missouri
Saw-whet owl	Undetermined status in Missouri
Bachman's sparrow	Rare in Missouri

(5) Mammals: Twelve species of rare of endangered mammals have been reported from the Meramec Basin and are listed below:

Species	Status
Indiana bat	Endangered in Missouri and nationally
Small-footed myotis	Endangered in Missouri
Gray bat	Endangered in Missouri
Keens bat	Rare in Missouri
Eastern big-eared bat	Endangered in Missouri
Black bear	Endangered in Missouri
Long-tailed weasel	Rare in Missouri
Spotted skunk	Undetermined status in Missouri
River otter	Endangered in Missouri
Red wolf	Endangered or extirpated in Missouri, considered endangered nationally
Mountain lion	Endangered in Missouri
Meadow jumping mouse	Undetermined status in Missouri

2.3 CULTURAL ELEMENTS

2.3.1 HISTORICAL SOCIO-CULTURAL DEVELOPMENT

2.3.1.1 Introduction

The Meramec Basin has three levels of settlement intensity. The St. Louis Metropolitan Area spreads into the northeast corner; small urban communities are found along major rail and highway routes, and the rest of the Basin is rural. The Union Lake Project Area, which is totally in Franklin County, is predominantly rural with small communities nearby along Highway 50, and Interstate 44.

2.3.1.2 Major Ethnic Groups

The first inhabitants of the Meramec Basin were American Indians of the Osage tribe. The French were the first European settlers arriving in the early 1700's. They were followed in the eighteenth and nineteenth centuries by the Spanish, Americans, and Germans. Distinct ethnic communities have dissolved with the passage of time and there are presently no well-defined ethnic communities in the project area.

2.3.1.3 Present Socio-Cultural Characteristics

The project Area and the Basin as a whole, except those urban areas near St. Louis, have a socio-cultural pattern typical of rural areas. Characteristic of this pattern is a strong family structure and an allegiance by residents to their particular town. The people maintain contacts with old friends and immediate business associates. They are mainly involved in activities associated with their church, town enterprises and individual interests. Although this pattern is changing due to recent population influxes from Metropolitan St. Louis, many residents are still influenced by their rural heritage. They are, in general, an individualistic people who are resentful of intrusion into their affairs by the Government or other "outsiders".

2.3.2 DEMOGRAPHY, ECONOMICS AND LAND USE

2.3.2.1 Demography

The population in Franklin County has been both steadily increasing and becoming more urbanized in recent years. By 1970 the county's population was 55,116; if future growth occurs at the rate it did from 1960 to 1970, by 1990 Franklin County is expected to reach nearly 88,500 (Figure 10). This projected level represents an increase of nearly 60 percent over the 1970 population.

This rate of growth becomes more impressive when compared to population growth for other areas. Population in Franklin County has been increasing at nearly three times the rate of the State during the 1960-70 period and almost twice as rapidly as the St. Louis, Missouri - Illinois Standard Metropolitan Statistical Area (SMSA). This pattern has been consistent over time; for example, from [illegible] to 1970 population had grown at an overall average rate of 57.3 percent as compared to the State's [illegible] percent.

The county has shown other signs of growth which indicate increasing urbanization. The urban - rural make-up of the population has changed greatly over the last [illegible] years. In 1930, the urban portion of the County's population was under [illegible] percent of the total; in 1970 the urban part was over [illegible] percent of the total (Figure 11). Conversely, the rural farm population has been steadily decreasing, from a 1930 level of [illegible] percent to a 1970 level of 12.[illegible] percent.

Employment by major industry group is another measure of the change which is occurring in Franklin County. Figure [illegible] shows that in [illegible], the industry group of agriculture, forestry, and fisheries employed [illegible] workers, [illegible] percent of the work force. Manufacturing was second with 3,18[illegible] workers, or 26.[illegible] percent of total workers. However, in 1970 agriculture had declined to 1,[illegible] workers, 6.5 percent of the total. Manufacturing ranked first in 1970, with 7,233 workers. Wholesaling and retailing, and services were second and third in 1970, with 17.[illegible] and [illegible] percent and 3,574 and [illegible],39[illegible] workers, respectively (Figure 13).

Other indicators such as educational status, median family income, population per household, and other sociological characteristics of Franklin County are comparable to those of Jefferson and Washington Counties and the City of St. Louis, although they are not as amenable as St. Louis County. In short, Franklin County is showing many of the important demographic characteristics of a growing culture.

[illegible] Economics

The demographic analysis of the area illustrates that Franklin County is shifting from an agrarian society to one with an urban emphasis. The economics of the county also indicate urbanization as well as overall growth. Other employment indicators along with those mentioned above, show expansion and urbanization of the economy. The percentage of employment in the professional and technical fields was increased from [illegible] percent in 1950 to 8.7 percent in 1970.

Industrial structure analysis also supports these trends. Nearly 36 percent of industrial employment is categorized as manufacturing for Franklin County, whereas the St. Louis SMSA, a major manufacturing center employs 29 percent in manufacturing. For further comparison, the national figure for manufacturing employment is about 33 percent. Manufacturing activity has grown steadily in recent years despite several national recessions. Between 1950 to 1970 manufacturing employment increased from [illegible]

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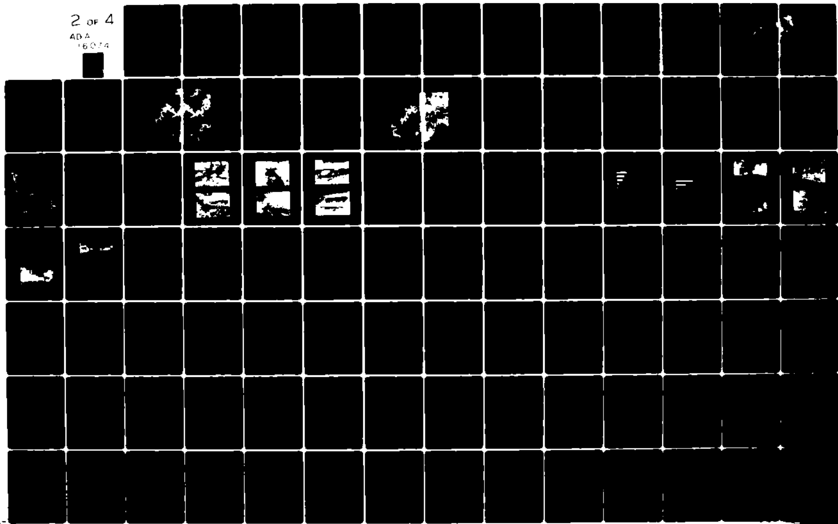

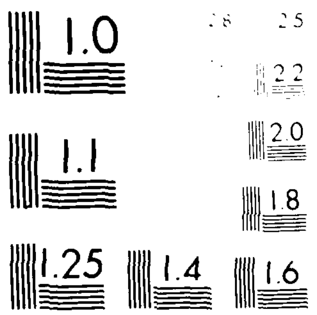
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to 7,233 or about 60 percent. Also, value added by manufacture was $56,000,000 in 1967, a 40 percent increase over the 1963 figure. New capital expenditures for 1967 totaled $1,700,000.

Other activities which mark urbanization and economic growth are retail sales which totaled $80,545,000 in 1967, a 10 percent increase from the 1963 total of $73,108,000 (1967 dollars). Receipts for selected services totaled $6,854,000, a 34 percent increase over the 1963 total of $5,117,400 (1967 dollars).

The analysis of pertinent data from census sources suggests that while Franklin County is not what might be termed a highly developed complex region in an economic sense, it seems to be moving in that direction.

2.3.2.3 Land Use

Franklin County today is largely a rural area with only about 6 percent or 35,021.1 acres of its 594,882.3 total acres developed (Figure 15). Figure 16 shows that of the developed land, 80 percent is used for either residences, parks, or streets. Notably, heavy industry, a large consumer of land, occupies a very small area (1 percent) of the developed land in the county. Of the undeveloped land, 353,000 acres or 59 percent of the total county area is in farm usage. This represents a 9 percent drop from 1964.

Current land use in the project area is about 35 percent cropland, 34 percent pastureland, 28 percent woodland, and 3 percent in roads, farmsteads, etc.

2.3.3 ARCHAEOLOGY

There are a minimum of 343 archaeological sites in the Meramec Basin, 44 of which occur in the Union Lake Project area (see Table 7), that have been officially recognized by the Archeological Survey of Missouri. The earliest known sites in the Basin are from the Archaic period. Archeologists believe that there are many other sites that have not been located.

The most common type of site in the project area is the village-campsite, which is usually located in the bottomlands. The other type of site found is the cave-rock shelter, which is found where bluffs are present. The Koenig site, a cave rock shelter, is on a study list for possible recommendation to the National Register of Historic Places (Traub, 1974).

Table 14. Located archaeological sites in the Union Lake Project Area

Village Campsites

Site Number	Cultural Affiliation	Comments
23 FR 86*	?	
FR 87*	?	
FR 88*	Mississippian	
FR 101	Woodland	
FR 102*	?	
FR 103*	?	
FR 104*	?	
FR 116*	?	
FR 118*	?	
FR 120*	?	
FR 121**	?	
FR 126*	Woodland	
FR 135	?	
FR 136*	?	
FR 137*	?	
FR 138*	?	
FR 139*	?	
FR 150*	?	
FR 173	?	
FR 174*	?	
FR 175	?	
FR 176**	Archaic	
FR 178*	?	
FR 180	?	
FR 181**	?	
FR 217	?	
FR 218*	?	
FR 223**	?	
FR 224*	?	
FR 232**	?	
FR 233*	Archaic-Early Woodland	
FR 234	Woodland	Tested

Cave and Rock Shelters

Site Number	Cultural Affiliation	Comments
23 FR 122*	?	
FR 123*	Late Woodland	Tested
FR 124*	Late Woodland	Tested
FR 125*	?	
FR 134*	?	
FR 170*	?	
FR 171*	?	
FR 172*	?	
FR 177*	?	
FR 179*	?	

* = Normal pool (619 ft. msl)
** = Flood pool (651 ft. msl)
Source: Evans, 1973

2.3.4 HISTORICAL SITES

Because of its key role in the westward expansion of the United States, St. Louis and its immediate vicinity have many sites of both local and national historical significance. A majority of these sites are located along the Mississippi and Missouri Rivers; few are in the Meramec Basin Area.

The only historic site listed in the Cumulative Inventory of Missouri Historic Sites and located in the Union Lake project area is Noser's Mill (see Figures 17 and 18). This is the only water mill house remaining in Franklin County. It is located on the Bourbeuse River south of Beaufort. This old rock mill was built in the early 1850's by Dietrich F. Voss. At present, the mill is used as a tavern and resort area. There are cabins and club houses nearby and the mill pond is occasionally used for swimming and fishing (Ryckman, 1973).

What remains of the Noser Mill site is a substantial, three-story stone mill structure associated with a four-story, cut-stone farm house which was the miller's home. The survival of both the mill and the miller's house is rare in Missouri, only one other example being recorded by the State Historical Survey and Planning Office to date. The mill and miller's home are listed on the Missouri Historical Survey's study list for recommendation to the National Register of Historic Places (Holmes, 1973). However, it is not presently listed on the National Register of Historic Places.

That portion of the Bourbeuse River Valley that lies in the project area possesses a variety of historic structures. These include 100 year old log structures, frame farmhouses, stone and brick buildings, water-powered gristmill sites, country schools, and cemeteries. While most have at best scant import above a local nature, nearly all possess varying degrees of cultural and architectural value.

In the Bourbeuse River Valley as in many other regions of Missouri, traditional agrarian ways of life are rapidly vanishing. The examples of this once common lifestyle notated in this inventory therefore have some historic import and constitute a finite and non-renewable resource.

A comprehensive professional survey involving the facilities of the State Historical Society of Missouri, the Missouri State Historical Survey and Planning Office, as well as extensive field research in the Union Lake project area has located 40 sites or structures of historic value. Information in the table below enumerating these sites has been extracted from a more comprehensive report prepared for the St. Louis District (see Johnson, 1974).

Table 15. Historic Sites, Union Lake Project Area

Site No.	Name/Description	Significance
1.	Farmhouse	
2.	Farmhouse	
3.	Neier Limestone Store Bldg.	
4.	Farmhouse	
5.	Log Cabin	
6.	John Door Farm	Log & Rock Structures
7.	Door School	Log Structure
8.	Lehr Farmhouse	
9.	Young's Mill	Ruins of Mill operating 1858 to 1867
10.	Log Cabin	
11.	Farmhouse	
12.	Voss Place	Late 19th Century brick farmhouse
13.	Log Structure & Cemetery	
14.	Log Cabin	Built ca. 1850
15.	Lead Mining Camp	
16.	Mierich Farm & Cemetery	
17.	R. H. Voss Farmhouse	Brick farmhouse built ca. 1890
18.	Bolzenius Log Cabin	Built over 100 yrs. ago
19.	Stuesse Log Cabin	Built mid 19th century, well preserved
20.	Crazy Fox Farm	Large limestone house
21.	South Beaufort school	One-room schoolhouse
22.	Wildhaber Place	
23.	Gist Place	
24.	Farmhouse	
25.	Noser's Mill	
26.	Farmhouse	
27.	Remmert Mine Area	Old Iron Mine
28.	Spring Creek School	
29.	Ahlemeyer Place	Frame and Log Structure
30.	Cemetery	
31.	Vallentine Cemetery	
32.	Farmhouse	
33.	Farmhouse	
34.	Farmhouse	
35.	Farmhouse	
36.	Farmhouse	
37.	Farmhouse	
38.	Cabin	
39.	Farmhouse	
40.	Champion City Bridge	Iron bridge constructed 1892

Source: Johnson, 1974

There are no sites in the Union Lake project area that are currently in the National Register of Historic Places. A number of sites in the project area may, however, meet the criteria for placement on the Register. Noser's Mill (site number 25), consisting of mill and miller's house, was constructed of limestone in the 1850's. It is the only such structure in Franklin County, and one of the few remaining such milling complexes in Missouri. Noser's Mill has been recommended by the Missouri Advisory Council on Historic Preservation for inclusion in the National Register and has been determined elegible.

In addition to this site, the Crazy Fox Farm, (site number 20), a large limestone building may meet National Register criteria. The structure has been brought to the attention of the Missouri Division of Natural Resources for consideration as to its eligibility.

2.3.5 HEALTH FACTORS

2.3.5.1 Local and State Public Health Programs

Franklin County has no local health program but is included in District 3 of the Missouri Division of Health which offers guidance, funding, and assistance to those counties with health units, and attempts to add additional services to those counties without health units.

2.3.5.2 Availability of Medical Services

The number of physicians and dentists per county varies in the Basin, generally decreasing in density as one goes farther from St. Louis. Franklin County has one of the highest proportions of medical personnel in the Basin area. Of the 37 towns canvassed in Franklin County, seven have physicians and six have dentists, for a total of 23 physicians and 19 dentists.

Franklin County has two hospitals: St. Francis Hospital in Washington and the Sullivan Community Hospital in Sullivan.

2.3.5.3 Public Health Problems

The following health problems that have been identified in the Meramec Basin also apply to the project area: (1) water quality, (2) sewage disposal, (3) solid waste disposal, (4) food related problems, (5) animal disease vectors, (6) a lack of planning and zoning ordinances, and (7) irritating vegetation.

2.3.5.4 Local Public Health Codes

In the State of Missouri, only those counties designated as first class have the power to legislate local public health codes to deal with these public health problems. In the Meramec Basin area, only St. Louis County has this authority; all other counties are dependent on the regulations, ordinances, and guidelines of the Missouri Division of Health.

2.3.6 PLANNING AND ZONING

2.3.6.1 State Planning and Zoning

At present, there are no statewide planning and zoning, building, electrical, plumbing, or minimum housing codes, however, pending state and federal land use planning and regulations gives reason for future optimism.

Six state regional planning commissions serve parts or all of the Meramec Basin. The East-West Gateway Coordinating Council which includes Franklin, St. Louis, and Jefferson Counties, is presently involved in examining water and sewer facilities, transportation, housing, land use, and parks within its region. The results of these studies are available to county and city zoning commissions, although implementation of any plans suggested depends solely upon local authorities.

2.3.6.2 County Planning and Zoning

Few Missouri counties have enacted planning and zoning codes which include standards for unincorporated areas. In the Basin, only St. Louis and Franklin Counties currently have county-wide planning ordinances, while St. Louis County is the only Basin county with comprehensive zoning codes. Franklin County has adopted mobile home park and subdivision regulations, as well as a building code; a land use plan for unincorporated portions of the county is currently under study.

2.3.6.3 City Planning and Zoning

In Missouri, incorporated areas are not subject to county zoning regulations. The Union Lake area has several cities that lack zoning or subdivision codes. Gerald has neither type of code, while Union and St. Clair lack subdivision ordinances. Pacific has both codes in effect. These communities have a much higher population density per square mile than unincorporated areas; thus, planning and zoning are especially desirable for efficient land use control and promotion of health and welfare.

2.3.6.4 Future Planning and Zoning Demands

Population growth, urbanization, industrial, and recreational development have increased the necessity for proper planning and zoning within the Basin area. Regional planning commissions have helped Basin counties develop comprehensive planning programs, but individual codes to implement these plans have generally not been initiated. Neither the commissions nor state agencies and health codes can meet all of the specific planning needs of the Basin communities; consequently, responsibility for the solution of local requirements at present rests primarily with the counties and cities themselves.

2.3.7 OUTDOOR RECREATION

2.3.7.1 Introduction

The Meramec Basin has provided recreational opportunities for many years for both Basin and Metropolitan St. Louis residents. In recent years, as transportation has improved, there has been continuous development of the Basin as a seasonal resort area resulting in a number of cottages being built along the major streams. As the St. Louis Metropolitan Area continues to expand, the Meramec Basin's importance as a recreational area will undoubtedly increase.

2.3.7.2 Public Lands

The majority of the recreational land in the Basin is found in the federally owned Clark National Forest, 200,000 acres of which are in the Meramec Basin. Other major publicly owned recreational lands in the Basin include Meramec State Park, Rockwood Reservation, Washington State Park, Huzzah Wildlife Area, and Sam A. Baker State Forest comprising about 34,000 acres. The only public-owned recreation facility in the Union Lake area is a boat access area at Union, Missouri, administered by the Missouri Department of Conservation.

There is more area available for hunting than any other activity in the Basin as a whole, while in the project area, fishing is the prominent outdoor recreational activity. Although there is some flat water in the project area, most of it is privately-owned or semi-public. Rivers and streams provide most of the water-related activities at the present time.

2.3.7.3 Private and Quasi-Public

There are a number of privately-owned recreational facilities in the Meramec Basin, including campgrounds, commercial caves, resident camps and amusement parks. A majority of these are along the Interstate 44 highway. At present, the Meramec Basin has no developed resort complexes such as the Lake of the Ozarks. Three of the privately-owned recreational facilities are of particular importance due to their popularity and uniqueness. These are: Meramec Caverns in Franklin County and Onondaga Cave in Crawford County, and Six Flags over Mid-America amusement park in St. Louis County. Private recreational facilities in the project area include Zig's Landing campground and trailer park, Trutsch Lakes fee fishing area, and the Noser Mill fishing and picnicking area.

2.3.7.4 Floating and Canoeing

The Meramec Basin has approximately 440 miles of streams which are used for canoeing and float fishing. The Bourbeuse in Franklin County is a winding river, floatable for nearly 108 miles across an airline distance of 27 miles. It is relatively small and slow and is not as clear as the streams to the south. However, it provides good bass fishing, relative solitude and privacy, and some attractive scenery including rock bluffs. It is seldom floatable above Bartel Bend (Highway H) in the summer.

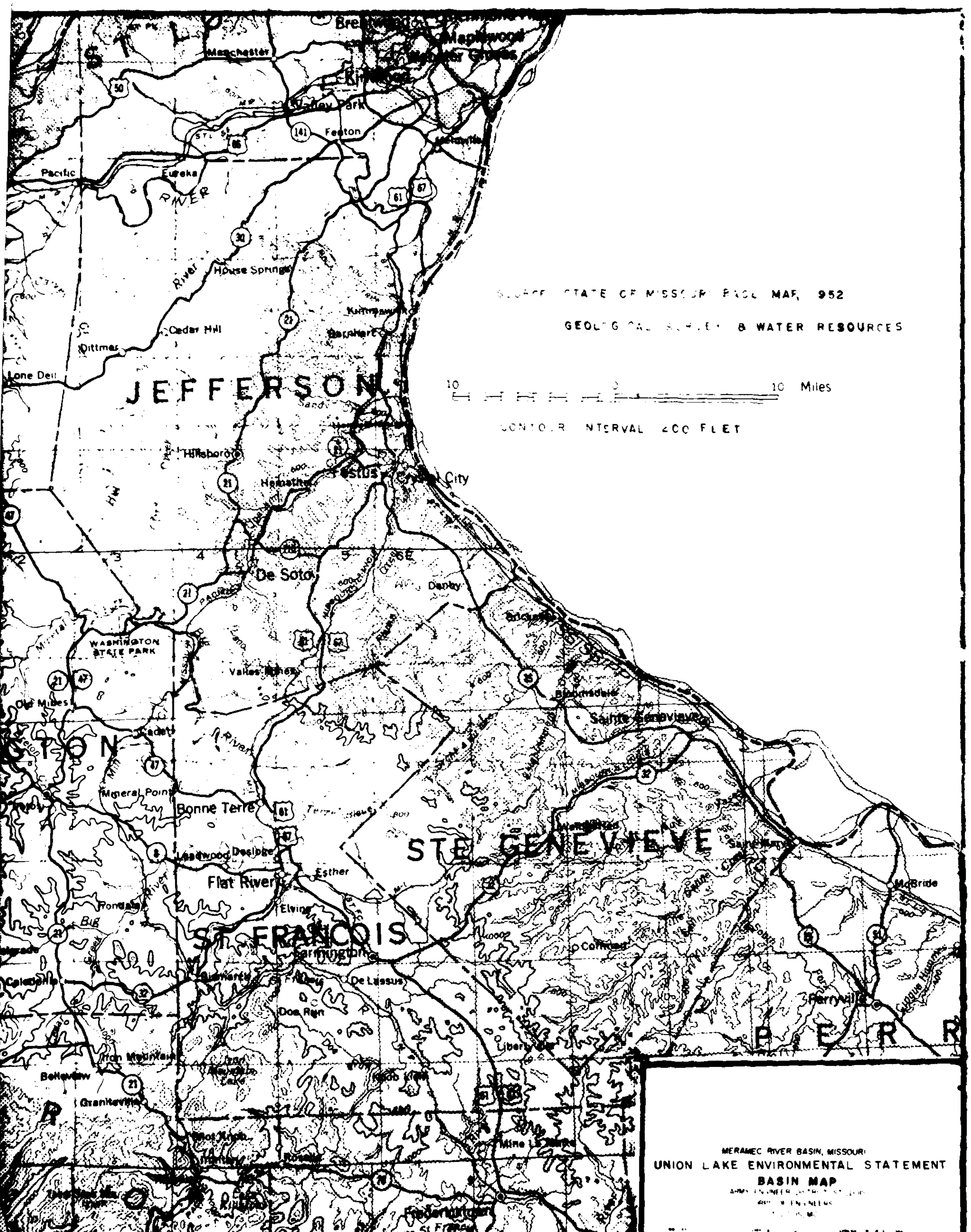
2.3.7.5 *Attendance at Recreation Areas*

No complete figures are available on the number of visitors to all recreational sites in the Meramec Basin. The greatest number of people visited Six Flags Over Mid-America, an amusement park along Highway I-44 about 25 miles from St. Louis; the second greatest number of people visited Meramec State Park in Franklin County near Sullivan, Missouri.

2.3.8 ESTHETICS

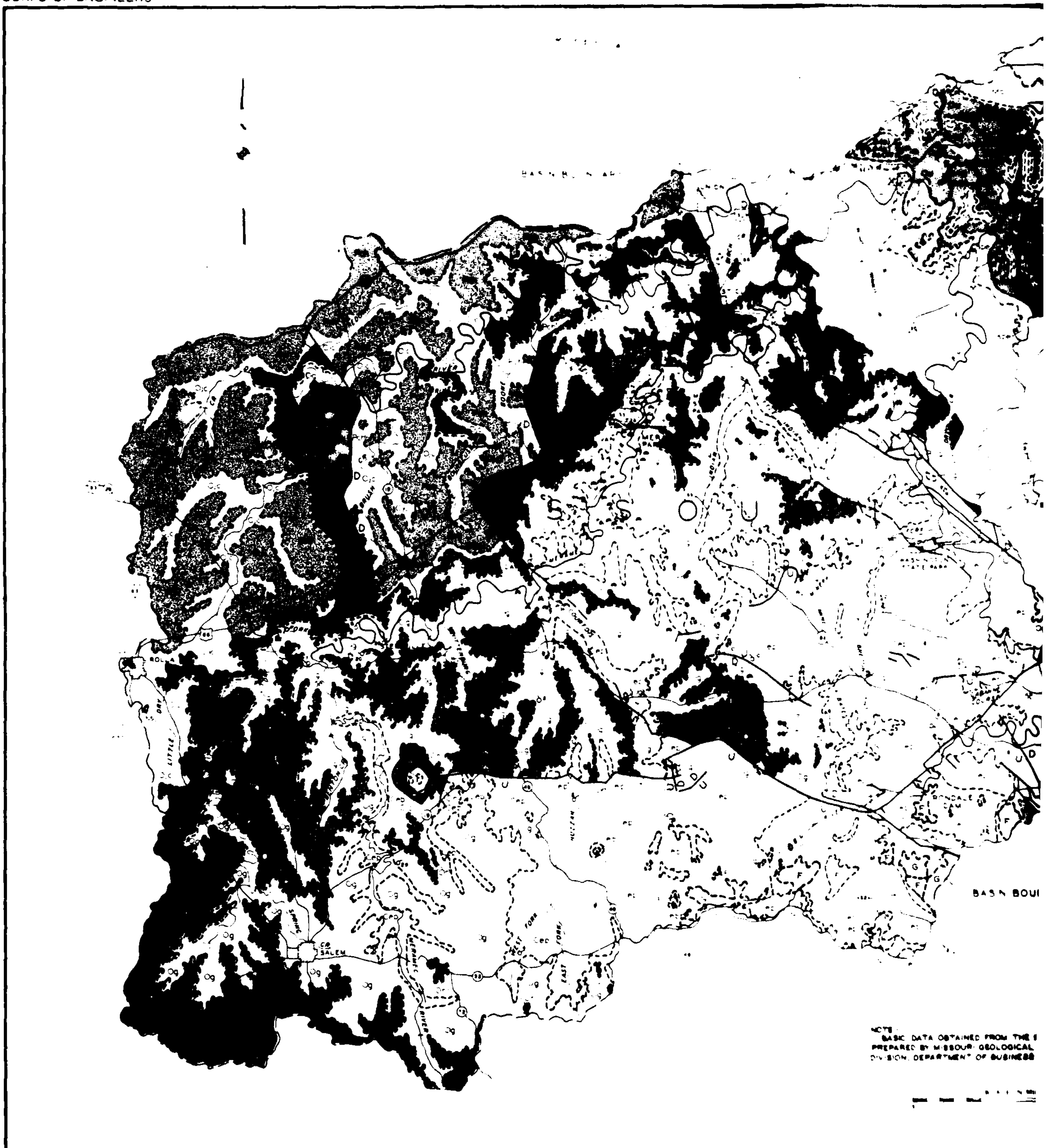
The Meramec River Basin offers a wide variety of conditions esthetically attractive to people of varied tastes. The rugged terrain along much of the main stream of the Meramec is in contrast with the more rolling hills of the Bourbeuse Valley. Tall, sheer bluffs, caves, gentle meadows, streams for fishing and boating, woods, wildlife, and pasture land provide many pleasing esthetic experiences. Figures 19 thru 24 show some typical views along the Bourbeuse River.


GASCONADE
FRANKLIN
JEFF
CRAWFORD
WASHINGTON
DENT
IRON
New Haven
Augusta
Washington
Labadie
Gray Summit
Pacific
Eureka
Villa Ridge
Union
Mount Sterling
Drake
Gerald
Leslie
Rosebud
Owensville
Bland
Canaan
Belle
Saint Clair
Cedar Hill
Dittmer
Lone Dell
Morrellton
Stanton
MERAMEC STATE PARK
Hillsboro
Oak Hill
Sullivan
Richwoods
Bourbon
Leasburg
WASHINGTON STATE PARK
Old Mines
Saint James
Cadet
Steelville
Cherry Valley
Mineral Point
Bonne Te
Rolla
Potosi
Keysville
Cherryville
Cook Station
Davisville
Belgrade
Caledonia
Dillard
Salem
Boss
Howes Mill
Stone Hill
Bellview
Graniteville
MERAMEC
RIVER
Meramec
Bourbeuse
Fork
MERIDIAN
800
1000
1200



MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
BASIN MAP
10 0 10 Miles
B WATER RESOURCES
JEFFERSON
ST FRANCOIS
STE GENEVIEVE
Maplewood
Manchester
Kirkwood
Valley Park
Fenton
Pacific
Eureka
RIVER
House Springs
Cedar Hill
Dittmer
Lone Dell
Hillsboro
Festus
Crystal City
De Soto
Danby
WASHINGTON STATE PARK
Old Mines
Cadet
Mineral Point
Bonne Terre
Leadwood
Desloge
Flat River
Esther
Elvins
Farmington
De Lassus
Doe Run
Bismarck
Iron Mountain
Belleview
Graniteville
Saint Genevieve
Bloomsdale
Weingarten
McBride
Perryville
Coffman
Mine La Motte
Fredericktown
P E R R

PLATE I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BASIN BOU
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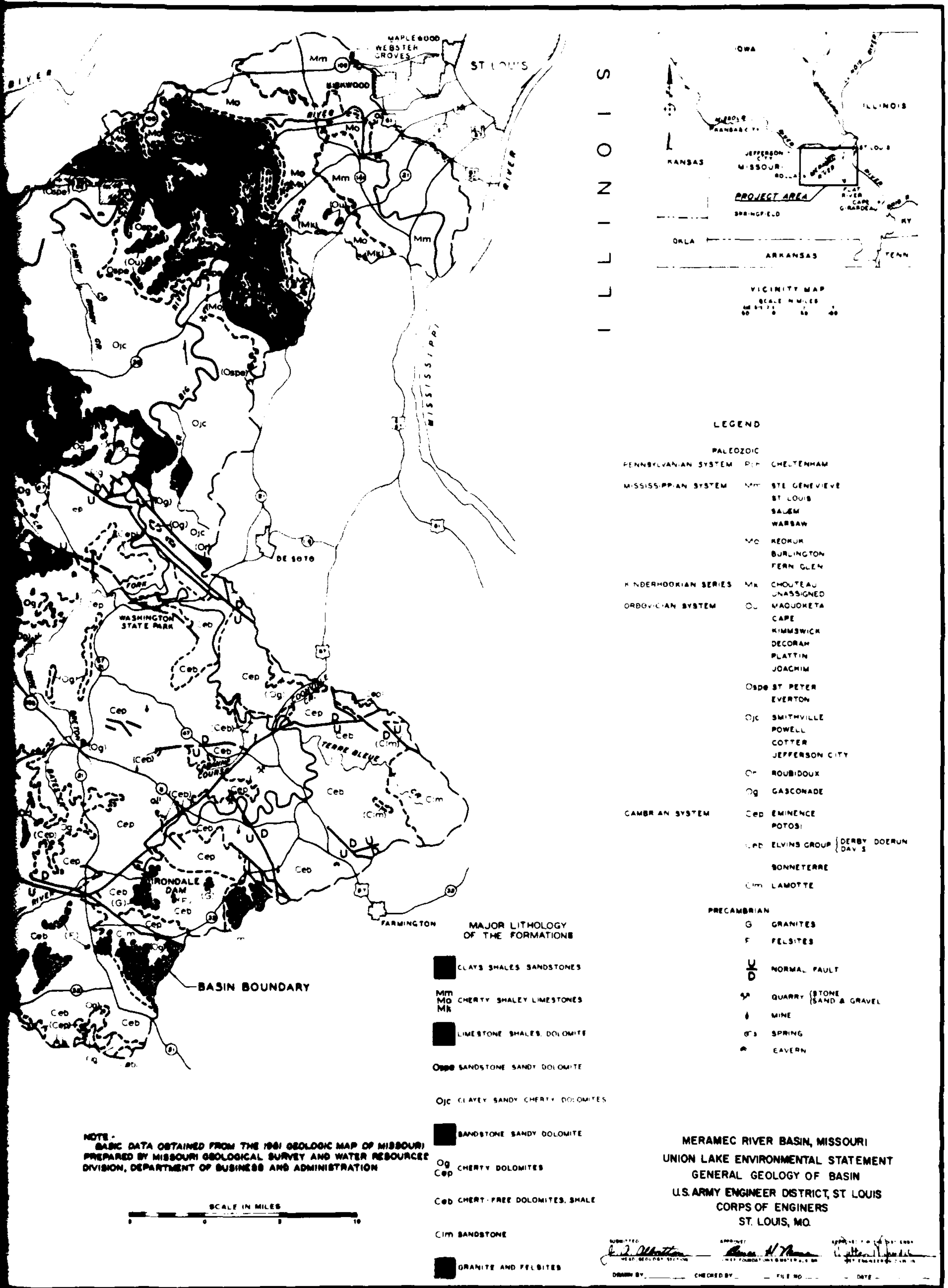
MAPLEWOOD
WEBSTER GROVES
KIRKWOOD
ST LOUIS
ILLINOIS
MISSISSIPPI
DE SOTO
WASHINGTON STATE PARK
TERRE BLEUE
IRONDALE DAM
FARMINGTON
BASIN BOUNDARY
IOWA
ILLINOIS
KANSAS
MISSOURI
PROJECT AREA
SPRINGFIELD
OKLA
ARKANSAS
TENN
KY
VICINITY MAP
LEGEND
PALEOZOIC
PENNSYLVANIAN SYSTEM
CHELTENHAM
MISSISSIPPIAN SYSTEM
STE GENEVIEVE
ST LOUIS
SALEM
WARSAW
Mo KEOKUK
BURLINGTON
FERN GLEN
KINDERHOOKIAN SERIES
Mk CHOUTEAU
UNASSIGNED
ORDOVICIAN SYSTEM
Ou MAQUOKETA
CAPE
KIMMSWICK
DECORAH
PLATTIN
JOACHIM
Ospe ST PETER
EVERTON
Ojc SMITHVILLE
POWELL
COTTER
JEFFERSON CITY
ROUBIDOUX
Og GASCONADE
CAMBRIAN SYSTEM
Cep EMINENCE
POTOSI
ELVINS GROUP
DERBY DOERUN
DAVIS
BONNETERRE
Clm LAMOTTE
PRECAMBRIAN
G GRANITES
F FELSITES
NORMAL FAULT
QUARRY
STONE
SAND & GRAVEL
MINE
SPRING
CAVERN
MAJOR LITHOLOGY OF THE FORMATIONS
CLAYS SHALES SANDSTONES
Mm Mo Mk CHERTY SHALEY LIMESTONES
LIMESTONE SHALES DOLOMITE
Ospe SANDSTONE SANDY DOLOMITE
Ojc CLAYEY SANDY CHERTY DOLOMITES
SANDSTONE SANDY DOLOMITE
Og Cep CHERTY DOLOMITES
Ceb CHERT-FREE DOLOMITES, SHALE
Clm SANDSTONE
GRANITE AND FELSITES
NOTE -
BASIC DATA OBTAINED FROM THE 1961 GEOLOGIC MAP OF MISSOURI PREPARED BY MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES DIVISION, DEPARTMENT OF BUSINESS AND ADMINISTRATION
SCALE IN MILES
MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
GENERAL GEOLOGY OF BASIN
U.S. ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MO.
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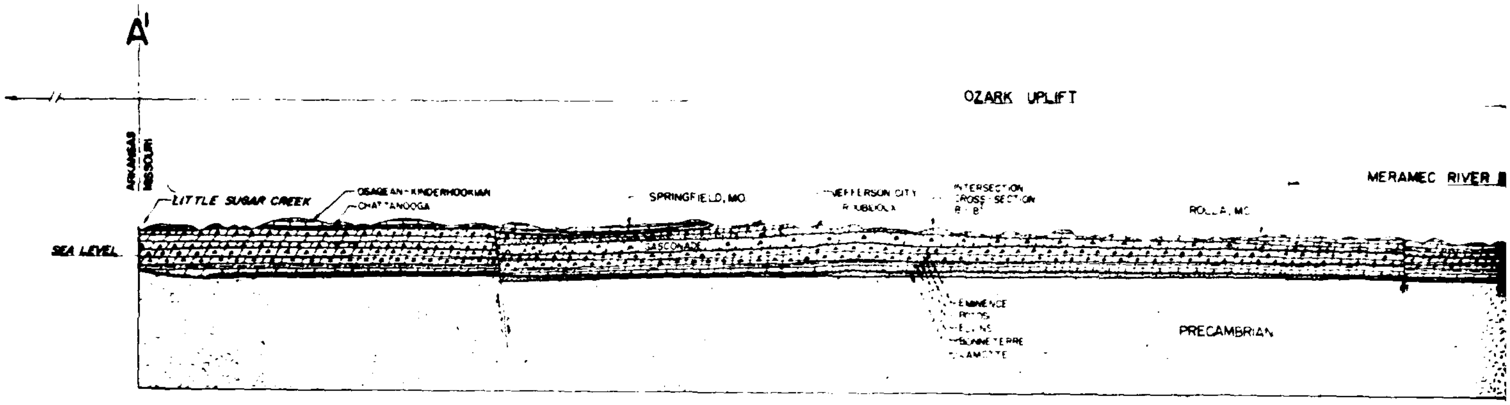
PLATE 2



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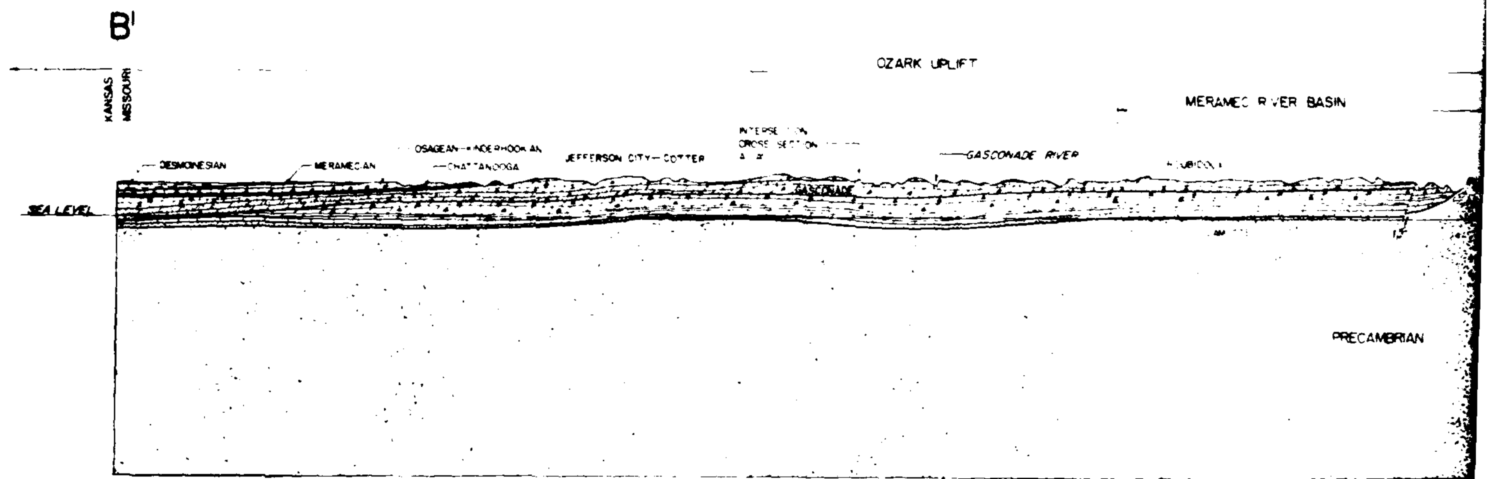

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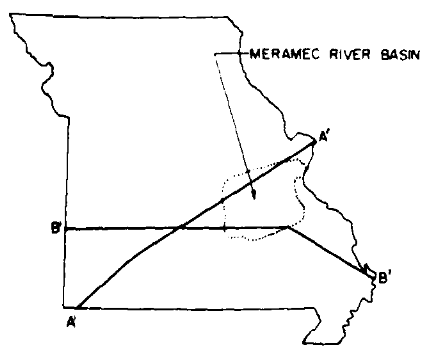

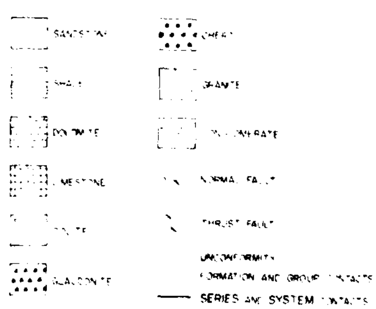

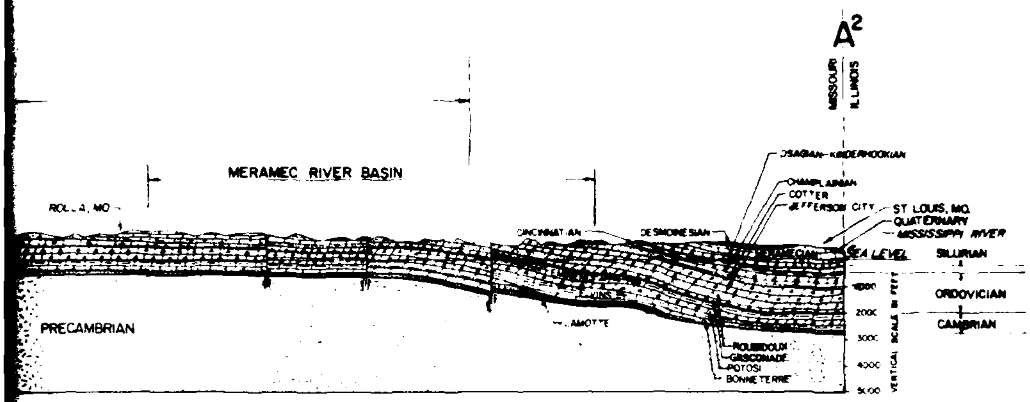

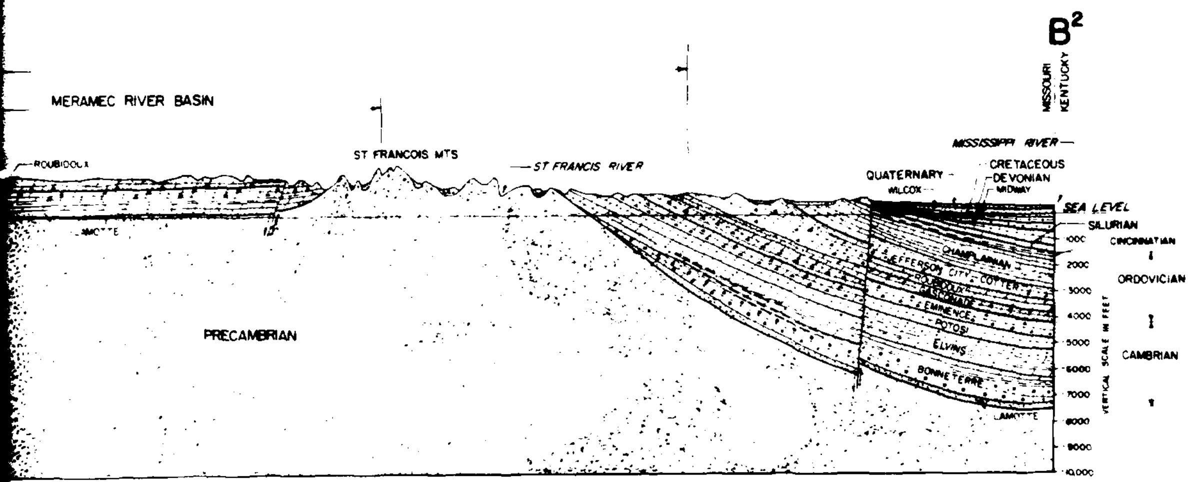

GEOLOGIC HIGHWAY MAP OF THE MID-CONTINENT REGION
PUBLISHED BY AAPG 1966

MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
GENERALIZED GEOLOGIC SECTIONS
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MO.

SUBMITTED — HEAD, GEOLOGY SECTION
APPROVED — CHIEF, FOUNDATIONS & MATERIALS BR
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PLATE 3

2

R4W
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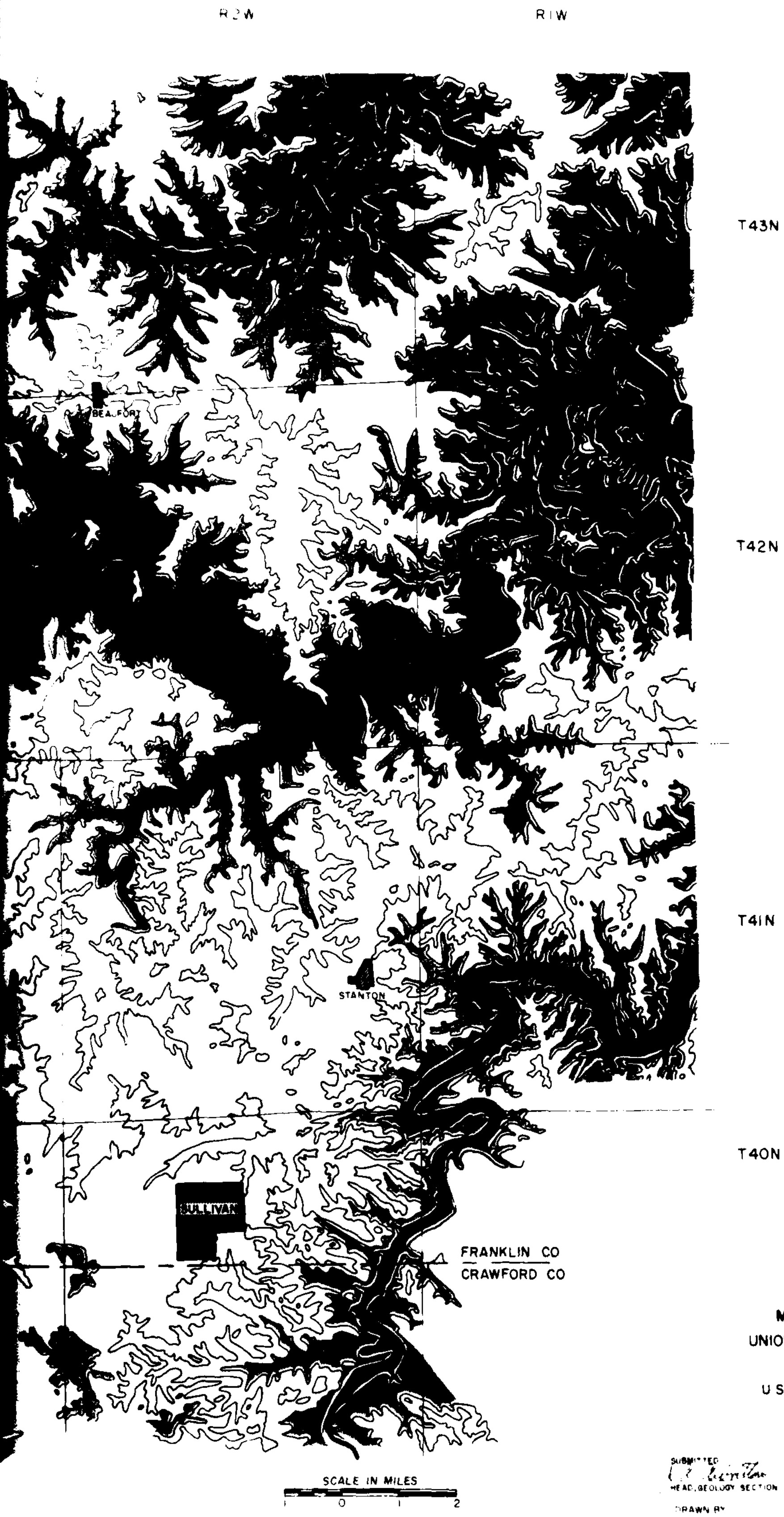
SASCONADE CO.
FRANKLIN CO.
GERALD
ROSEBUD
BOURBEUSE
STANTON
SULLIVAN
SCALE IN



LEGEND

GROUND ELEVATIONS – M S L

- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1000
- 1000 - 1100
- FLOOD CONTROL POOL

MERAMEC RIVER BASIN, MISSOURI

UNION LAKE ENVIRONMENTAL STATEMENT

RELIEF MAP

U S ARMY ENGINEER DISTRICT, ST LOUIS

CORPS OF ENGINEERS

ST LOUIS, MO

SUBMITTED	APPROVED	APPROVED FOR THE DIST ENGR
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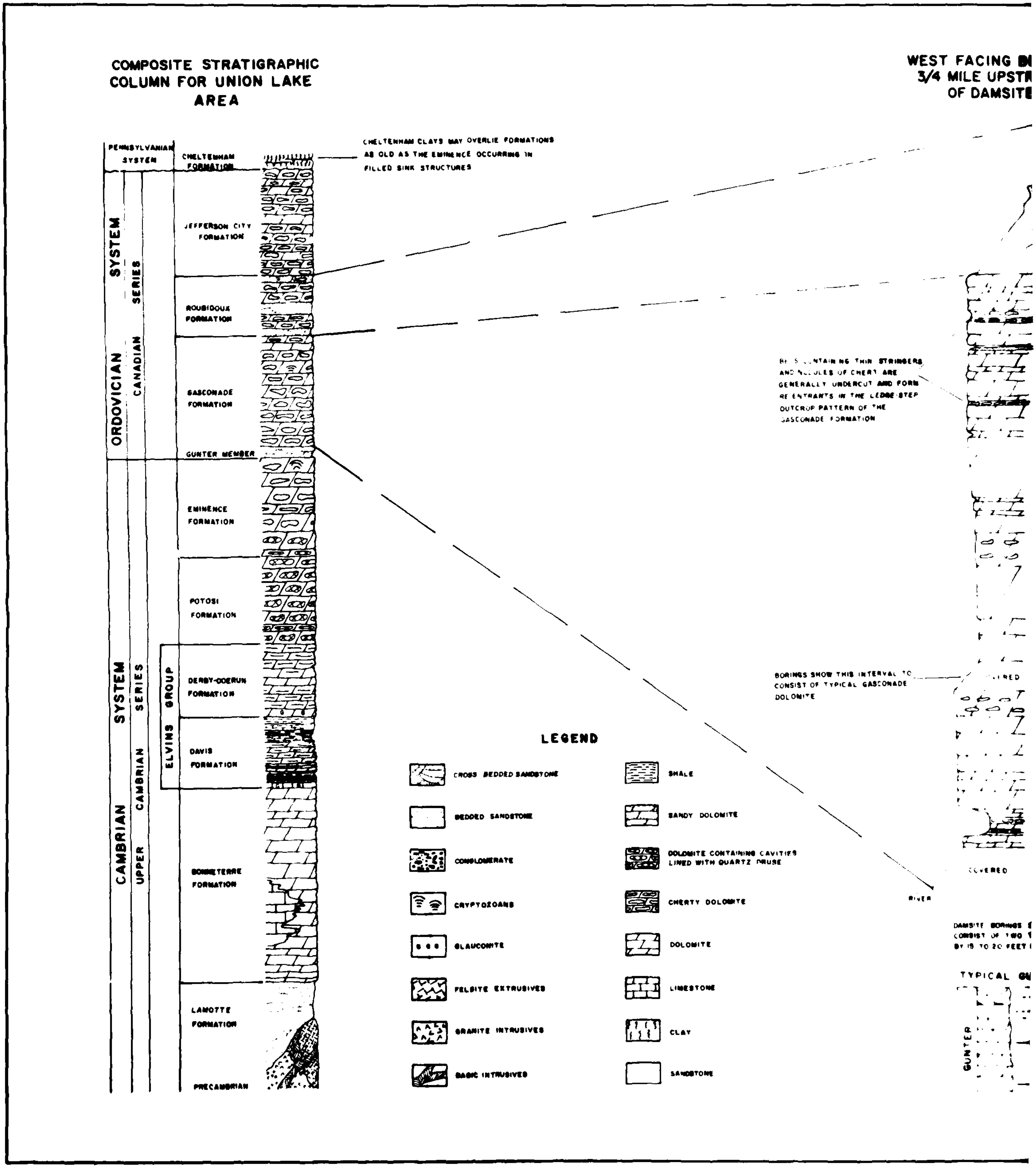
COMPOSITE STRATIGRAPHIC COLUMN FOR UNION LAKE AREA
PENNSYLVANIAN SYSTEM
CHELTENHAM FORMATION
CHELTENHAM CLAYS MAY OVERLIE FORMATIONS AS OLD AS THE EMINENCE OCCURRING IN FILLED SINK STRUCTURES
ORDOVICIAN SYSTEM
CANADIAN SERIES
JEFFERSON CITY FORMATION
ROUBIDOUX FORMATION
GASCONADE FORMATION
GUNTER MEMBER
CAMBRIAN SYSTEM
UPPER CAMBRIAN SERIES
ELVINS GROUP
EMINENCE FORMATION
POTOSI FORMATION
DERBY-DOERUN FORMATION
DAVIS FORMATION
BONNETERRE FORMATION
LAMOTTE FORMATION
PRECAMBRIAN
LEGEND
CROSS BEDDED SANDSTONE
BEDDED SANDSTONE
CONGLOMERATE
CRYPTOZOANS
GLAUCONITE
FELSITE EXTRUSIVES
GRANITE INTRUSIVES
BASIC INTRUSIVES
SHALE
SANDY DOLOMITE
DOLOMITE CONTAINING CAVITIES LINED WITH QUARTZ DRUSE
CHERTY DOLOMITE
DOLOMITE
LIMESTONE
CLAY
SANDSTONE
WEST FACING
3/4 MILE UPST
OF DAMSIT
CONTAINING THIN STRINGERS AND NODULES OF CHERT ARE GENERALLY UNDERCUT AND FORM RE ENTRANTS IN THE LEDGE-STEP OUTCROP PATTERN OF THE GASCONADE FORMATION
BORINGS SHOW THIS INTERVAL TO CONSIST OF TYPICAL GASCONADE DOLOMITE
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RIVER
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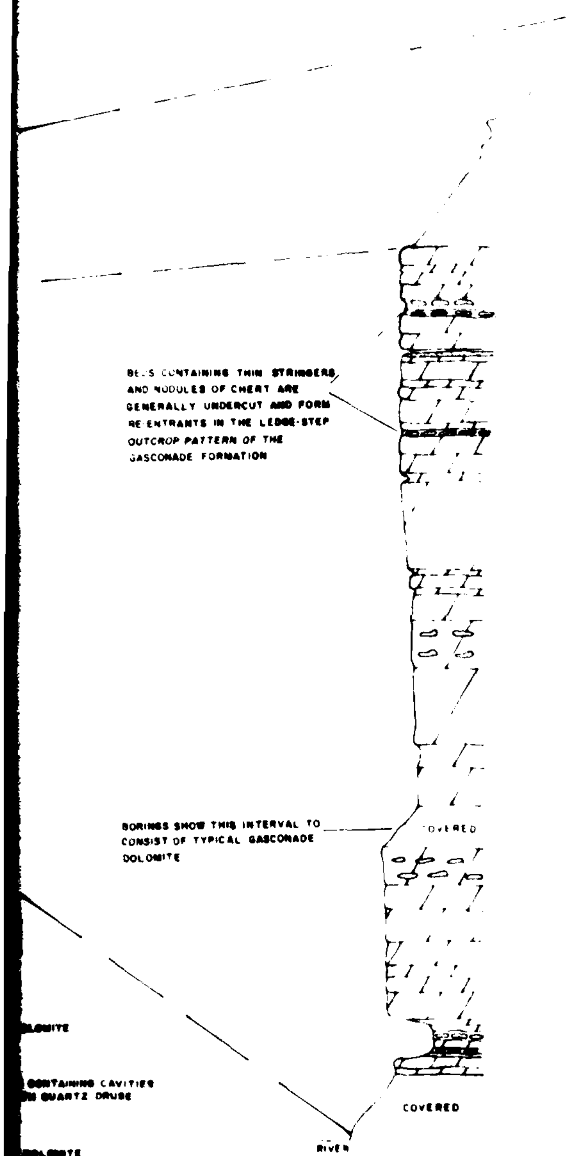
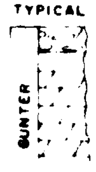
CONSIST OF TWO
BY 15 TO 20 FEET
TYPICAL
GUNTER

WEST FACING BLUFF
3/4 MILE UPSTREAM
OF DAMSITE



DAMSITE BORINGS SHOW THE GUNTER MEMBER TO CONSIST OF TWO THIN SANDSTONES SEPARATED BY 15 TO 20 FEET OF TYPICAL GASCONADE DOLOMITE

TYPICAL GUNTER (MARKER BED ZONE)



OVERBURDEN — THE OVERBURDEN CONSISTS PRIMARILY OF RESIDUAL SOILS, CHARACTERIZED BY A CHERTY CLAY MANTLE, FINE SANDY LOAM AND CHERTY SANDY LOAM

ROUBIDOUX FORMATION — PREDOMINATELY A QUARTZOSE SANDSTONE WITH LESSER AMOUNTS OF SLIGHTLY CHERTY DOLOMITE. THE SANDSTONE IS COMPOSED OF FINE TO MEDIUM GRAINED, SUBROUNDED, FROSTED QUARTZ SAND, TIGHTLY TO LOOSELY CEMENTED. COLORS ARE COMMONLY RED, TAN OR LIGHT YELLOW AT THE SURFACE AND WHITE IN THE SUBSURFACE

GASCONADE FORMATION — PREDOMINANTLY A LIGHT BROWN, GREY, CHERTY, FINE TO COARSE CRYSTALLINE DOLOMITE. FOSSILS ARE RARE EXCEPT FOR WIDESPREAD MASSES OF CRYPTOZOAN

VARIETIES OF CHERT INCLUDE
1 OOLITIC
2 SMOOTH, WHITE PORCELANEOUS
3 WHITE, POROUS, EARTHY
4 BROWN AND GREY BANDED
5 BLUISH, DENSE, HARD, AND SHARP

CHERT OCCURS AS HORIZONTALLY DISCONTINUOUS NODULES, FINGERS, AND BEDS

MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
STRATIGRAPHY
U S ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST LOUIS, MO

DRAWN BY · CHECKED BY · DATE

PLATE 5

R 4 W
R 3 W
R 2 W
T 43 N
T 42 N
T 41 N
T 40 N
GASCONADE CO.
FRANKLIN CO.
ROSEBUD
GERALD
BEAUFORT
LEASBURG
FAULT

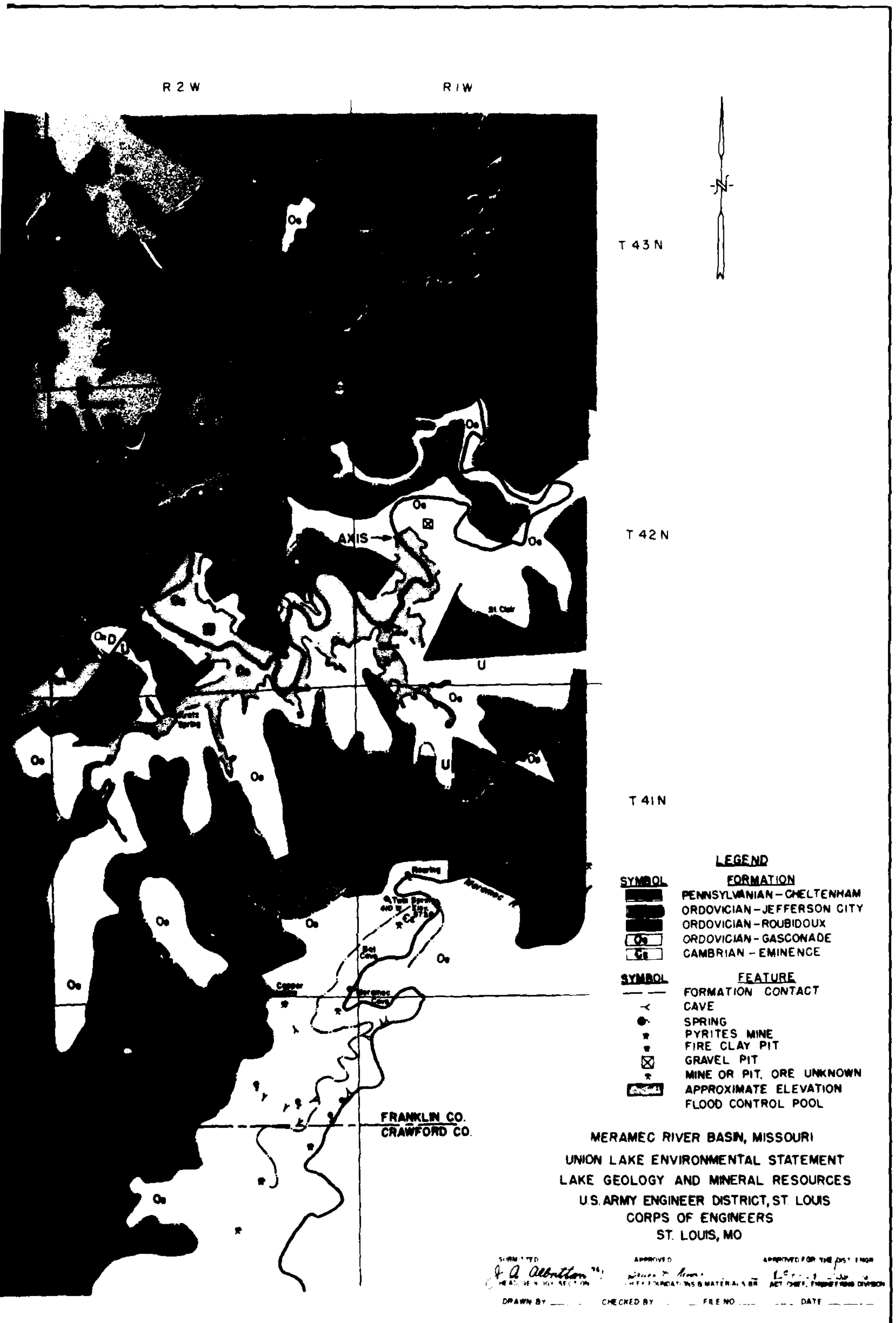
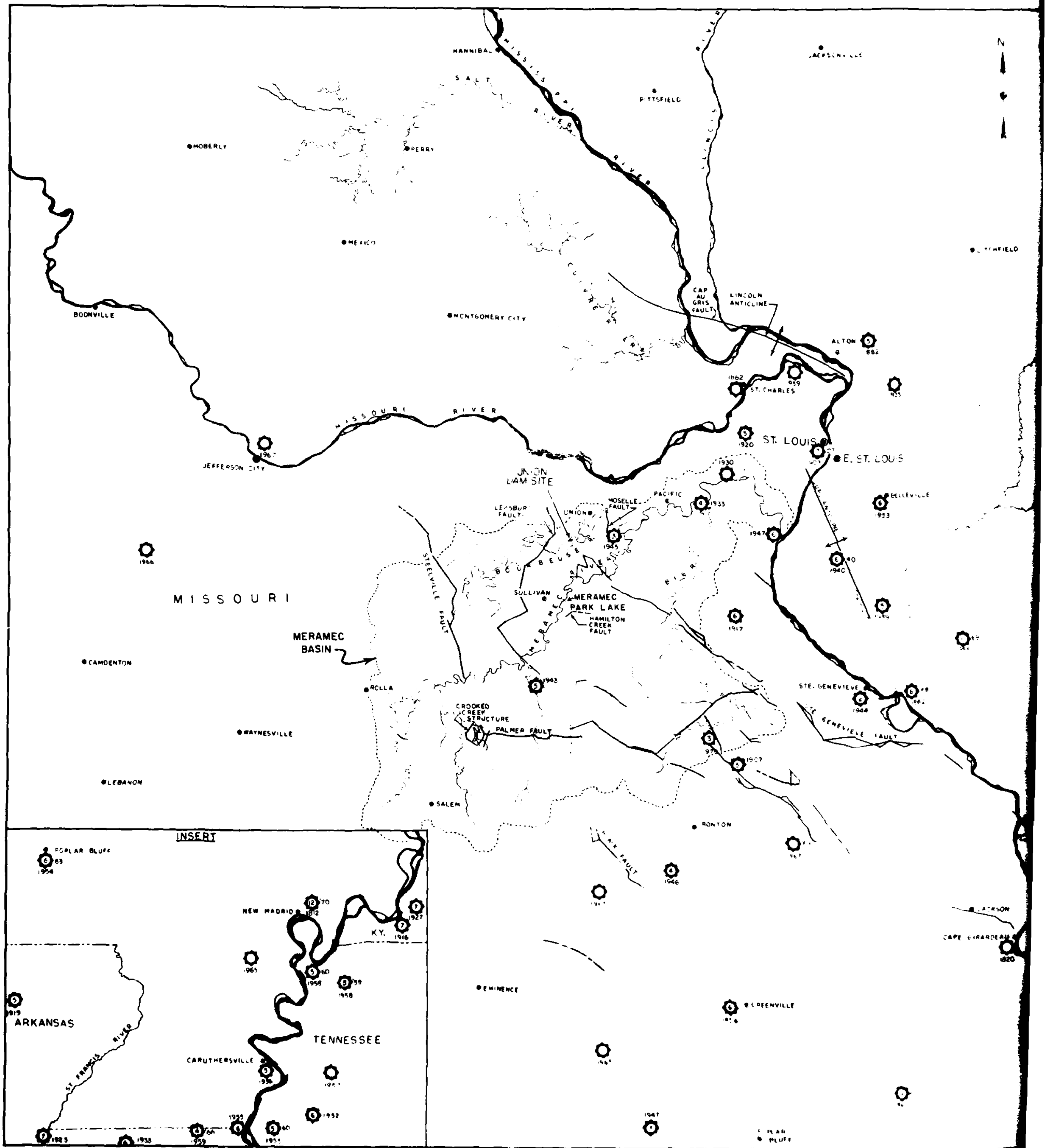
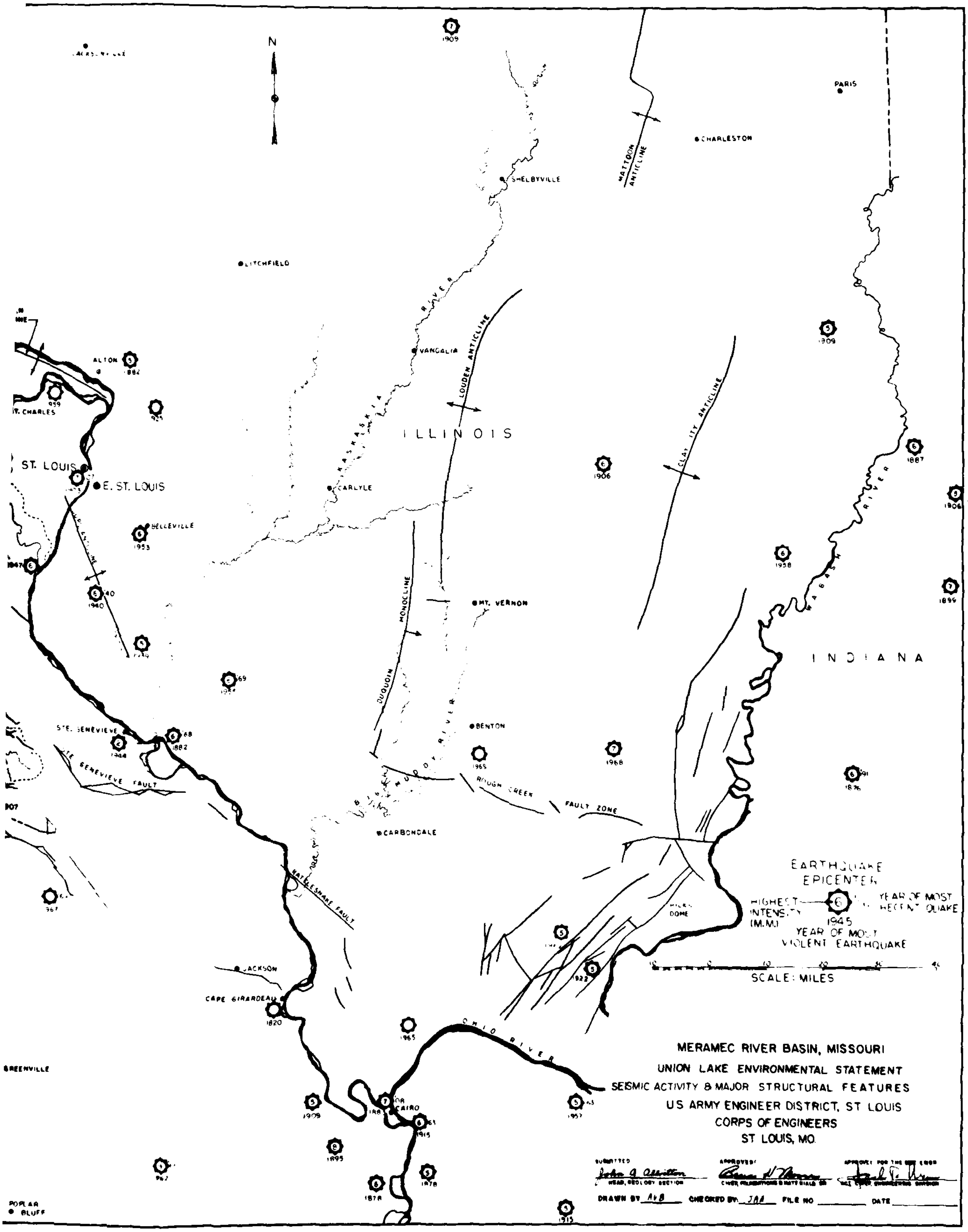

R 2 W
R I W
T 43 N
T 42 N
T 41 N
N
AXIS
St Clair
U
FRANKLIN CO.
CRAWFORD CO.
LEGEND
SYMBOL
FORMATION
PENNSYLVANIAN - CHELTENHAM
ORDOVICIAN - JEFFERSON CITY
ORDOVICIAN - ROUBIDOUX
ORDOVICIAN - GASCONADE
CAMBRIAN - EMINENCE
SYMBOL
FEATURE
FORMATION CONTACT
CAVE
SPRING
PYRITES MINE
FIRE CLAY PIT
GRAVEL PIT
MINE OR PIT, ORE UNKNOWN
APPROXIMATE ELEVATION
FLOOD CONTROL POOL
MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
LAKE GEOLOGY AND MINERAL RESOURCES
U.S. ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MO
APPROVED
DRAWN BY
CHECKED BY
FILE NO
DATE

PLATE 6


HANNIBAL
PITTSFIELD
SALT RIVER
MISSISSIPPI RIVER
MOBERLY
PERRY
MEXICO
CUIVRE RIVER
BOONVILLE
MONTGOMERY CITY
CAP AU GRIS FAULT
LINCOLN ANTICLINE
ALTON
ST. CHARLES
MISSOURI RIVER
JEFFERSON CITY
ST. LOUIS
E. ST. LOUIS
UNION DAM SITE
LEASBURG FAULT
UNION
MOSELLE FAULT
PACIFIC
BELLEVILLE
BOURBEUSE RIVER
MISSOURI
STEELVILLE FAULT
SULLIVAN
MERAMEC PARK LAKE
HAMILTON CREEK FAULT
MERAMEC BASIN
CAMDENTON
ROLLA
STE. GENEVIEVE
STE. GENEVIEVE FAULT
CROOKED CREEK STRUCTURE
PALMER FAULT
WAYNESVILLE
LEBANON
SALEM
BONTON
JACKSON
CAPE GIRARDEAU
EMINENCE
GREENVILLE
INSERT
POPLAR BLUFF
NEW MADRID
KY.
ARKANSAS
TENNESSEE
ST. FRANCIS RIVER
CARUTHERSVILLE

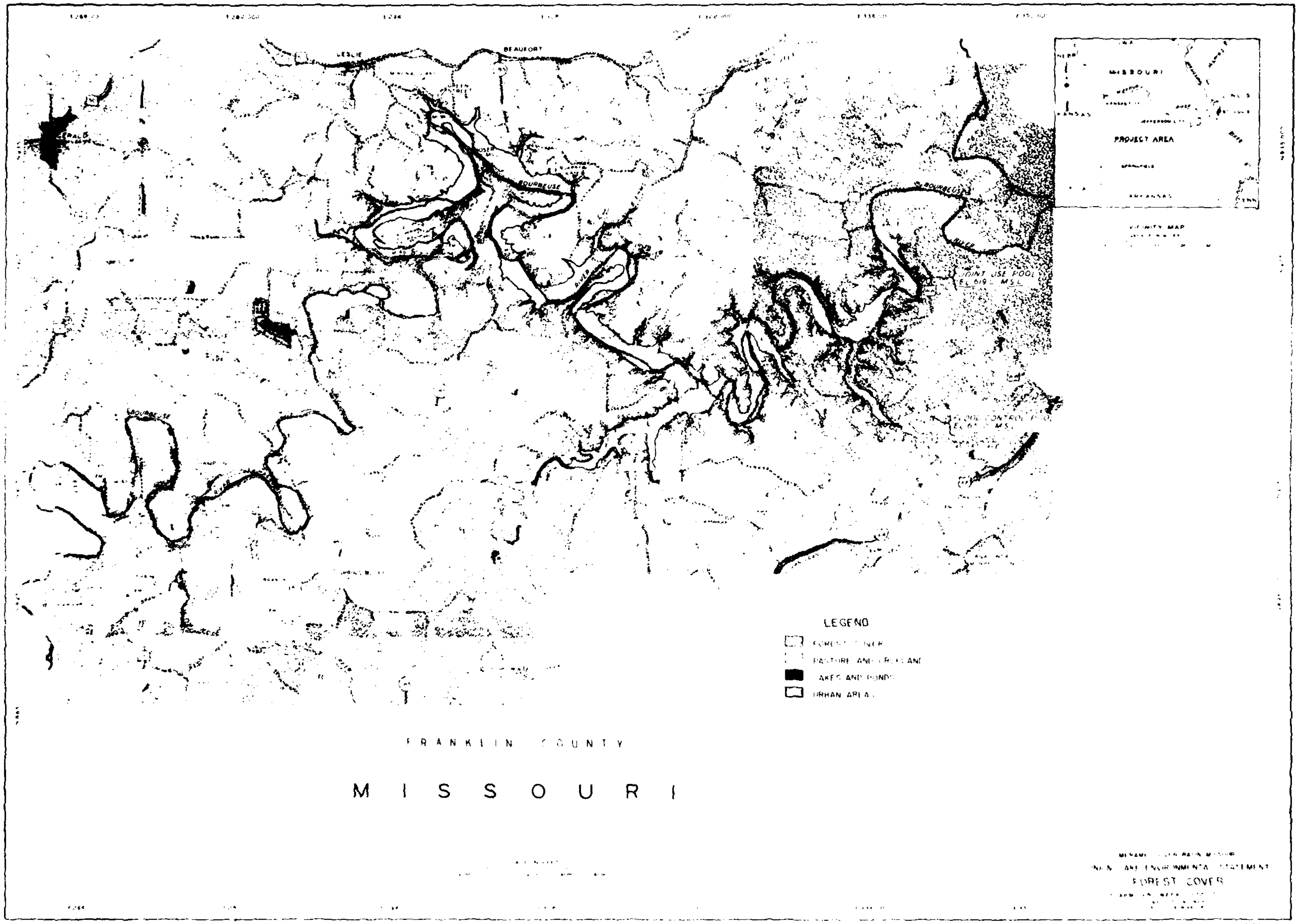


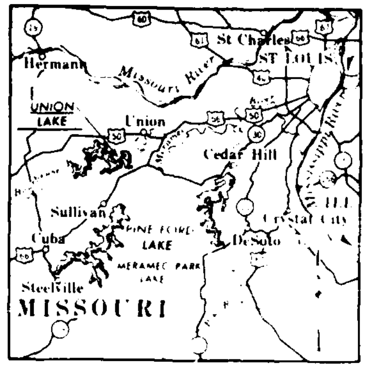
MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
SEISMIC ACTIVITY & MAJOR STRUCTURAL FEATURES
US ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST LOUIS, MO.

SUBMITTED: John G. Allritton, HEAD, GEOLOGY SECTION — APPROVED: [signature], CHIEF, FOUNDATIONS & MATERIALS BR. — APPROVED FOR THE DIST. ENGR: [signature]

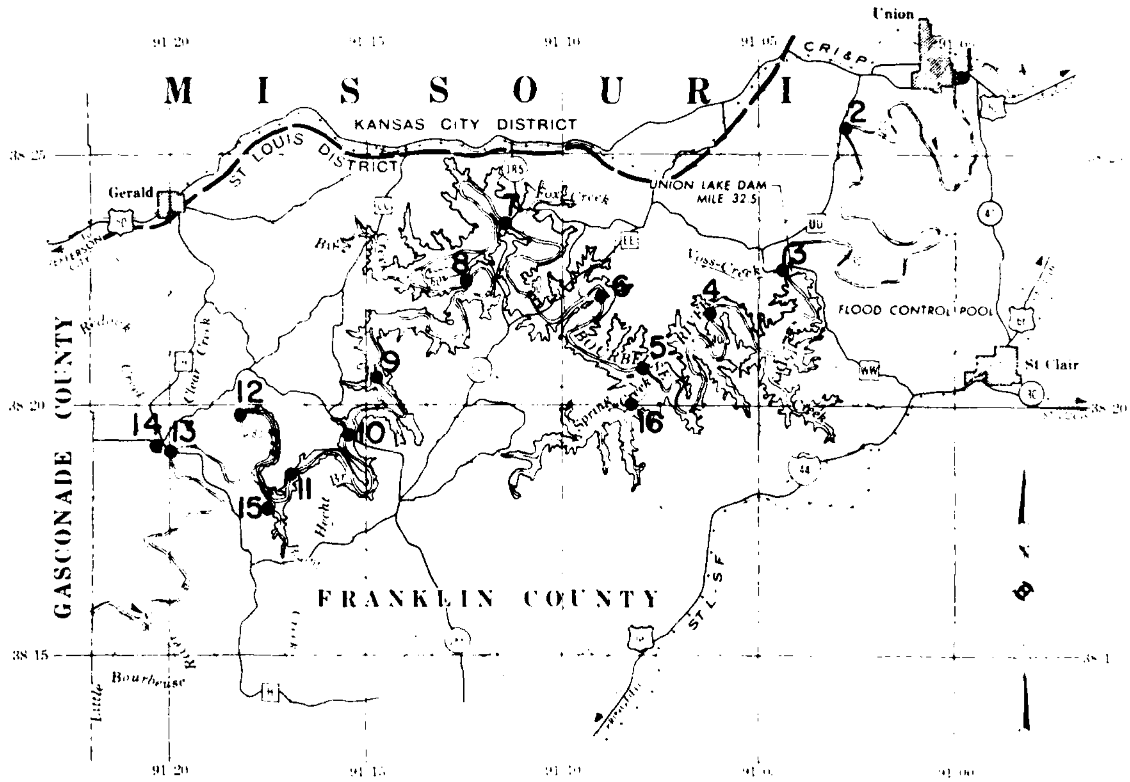
DRAWN BY A.B. CHECKED BY JAA FILE NO ______ DATE ______

PLATE 7


LESLIE
BEAUFORT
BOURBEUSE
RIVER
MISSOURI
PROJECT AREA
ARKANSAS
VICINITY MAP
JOINT USE POOL
LEGEND
PASTURE AND CROPLAND
URBAN AREA
FRANKLIN COUNTY
MISSOURI
FOREST COVER



VICINITY MAP



LEGEND

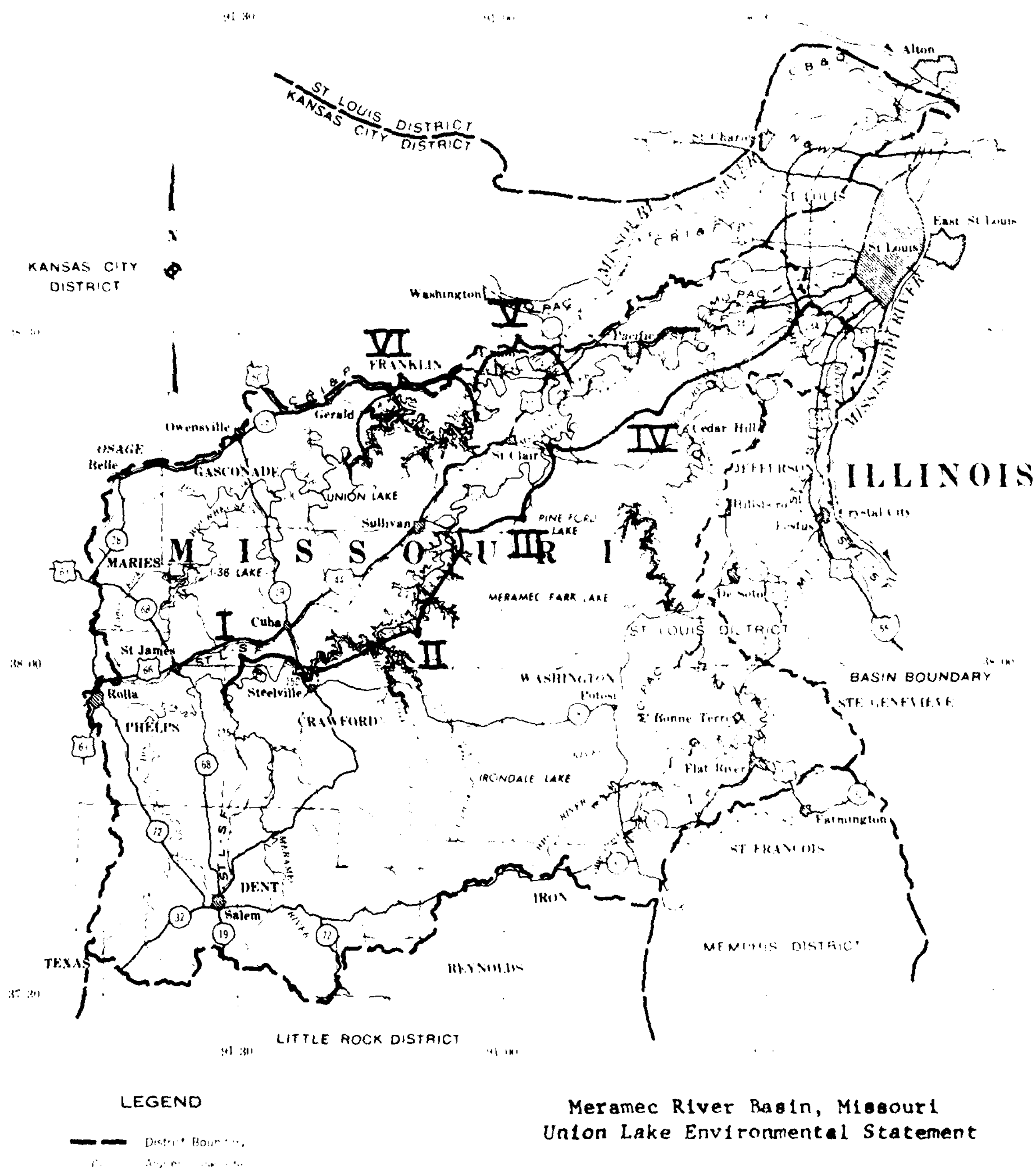
— — District Boundary

• 7 Sampling Station

Sampling Locations

UNION LAKE

PLATE



Meramec River Basin, Missouri
Union Lake Environmental Statement

COLLECTION LOCATIONS
FOR BIVALVE MOLLUSCS

U. S. Army Engineer District, St. Louis
Corps of Engineers

PLATE

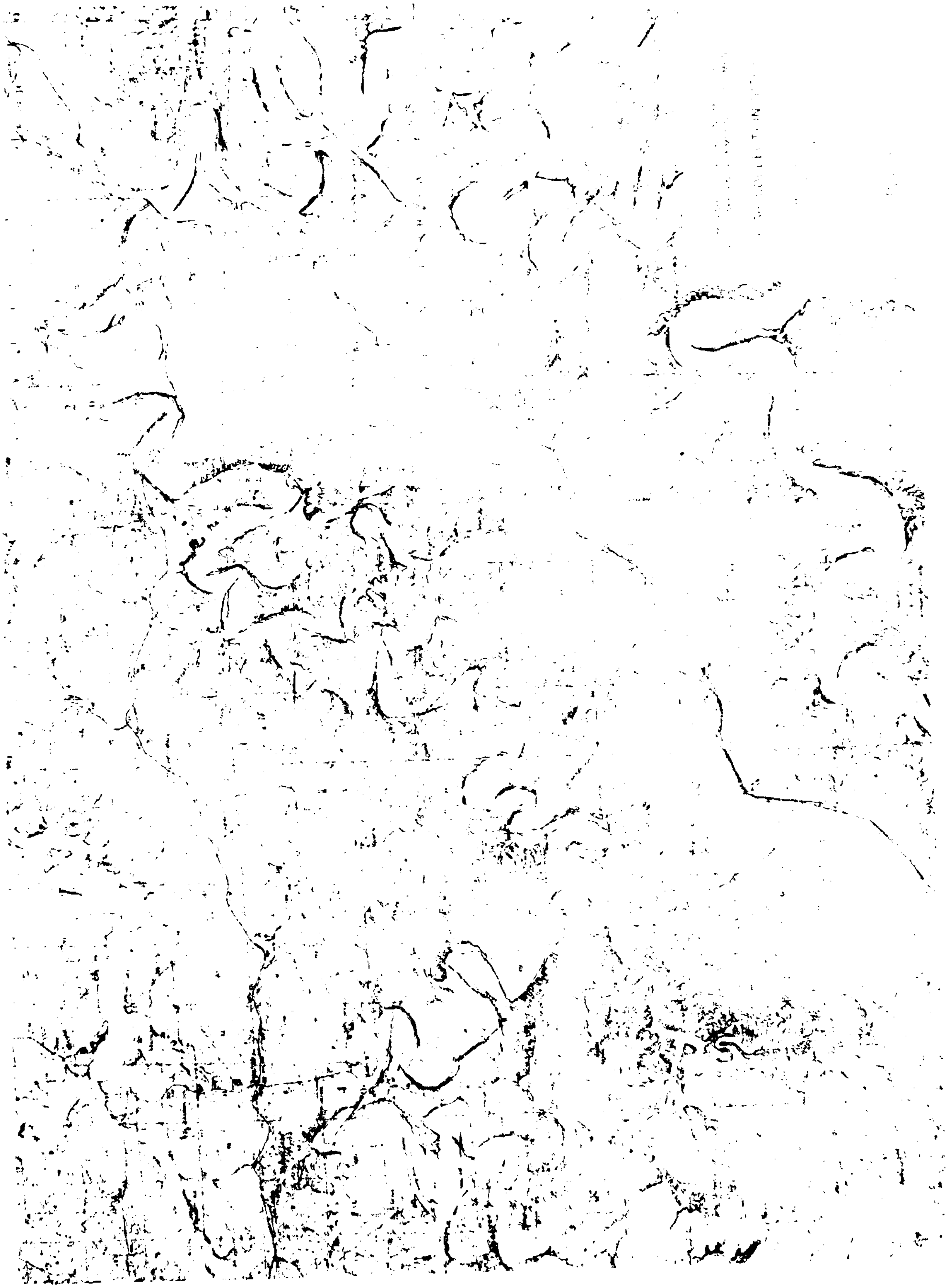
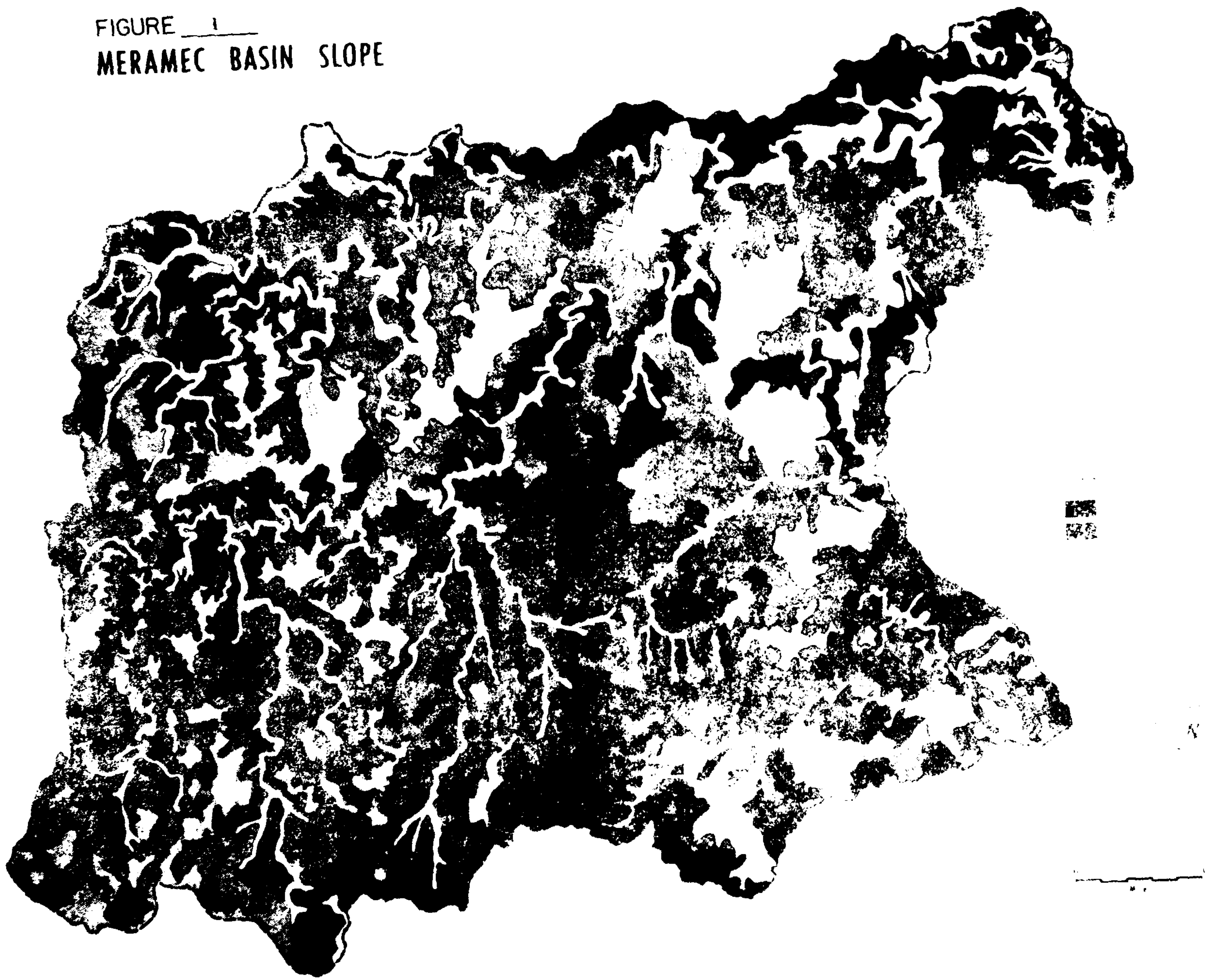


FIGURE 1
MERAMEC BASIN SLOPE



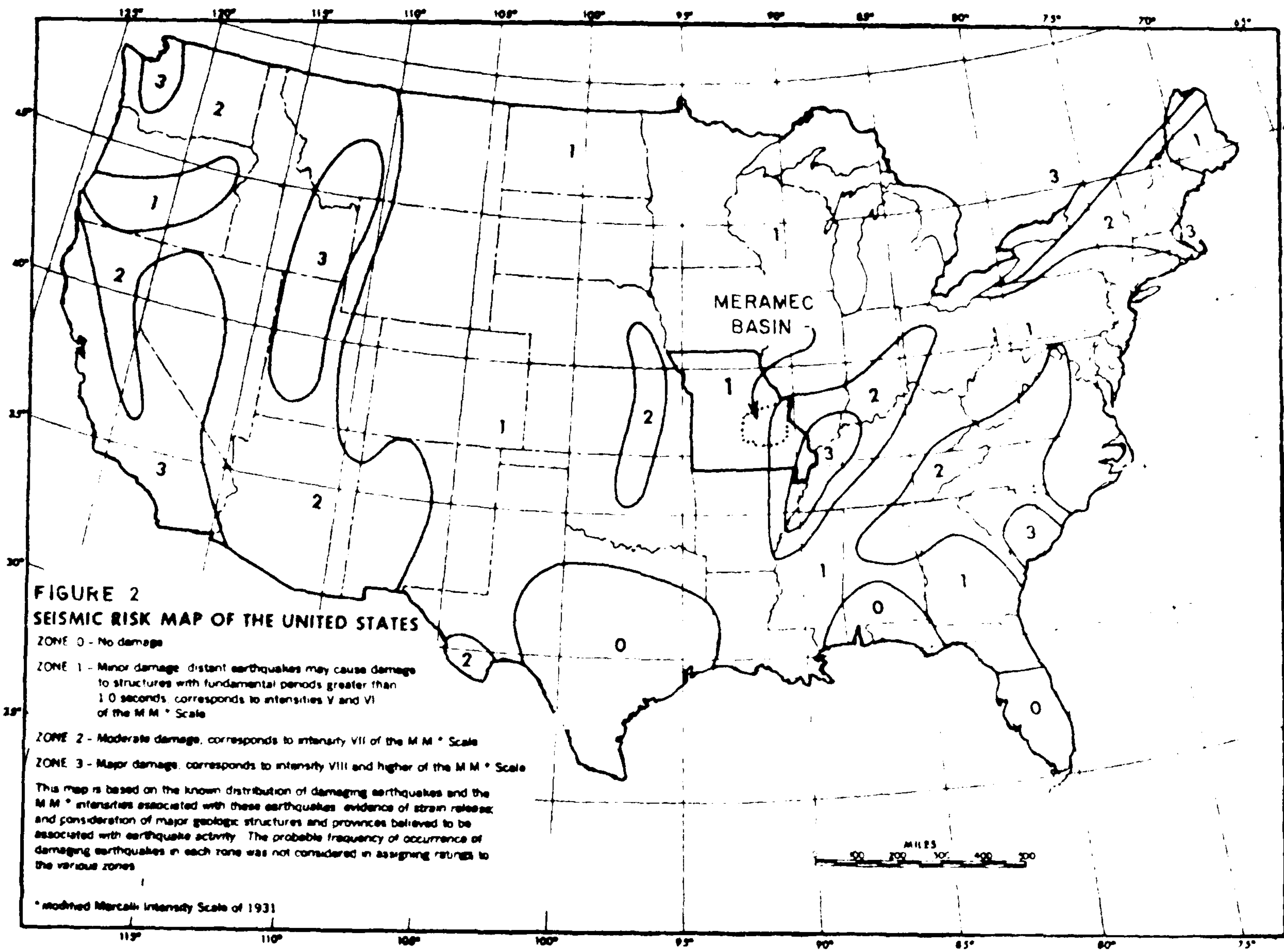


FIGURE 2

SEISMIC RISK MAP OF THE UNITED STATES

ZONE 0 - No damage

ZONE 1 - Minor damage, distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 seconds, corresponds to intensities V and VI of the M.M.* Scale

ZONE 2 - Moderate damage, corresponds to intensity VII of the M.M.* Scale

ZONE 3 - Major damage, corresponds to intensity VIII and higher of the M.M.* Scale

This map is based on the known distribution of damaging earthquakes and the M.M.* intensities associated with these earthquakes, evidence of strain release, and consideration of major geologic structures and provinces believed to be associated with earthquake activity. The probable frequency of occurrence of damaging earthquakes in each zone was not considered in assigning ratings to the various zones.

* Modified Mercalli Intensity Scale of 1931

FIGURE 3. DRAINAGE PATTERNS OF MERAMEC, BOURBEUSE AND BIG RIVERS

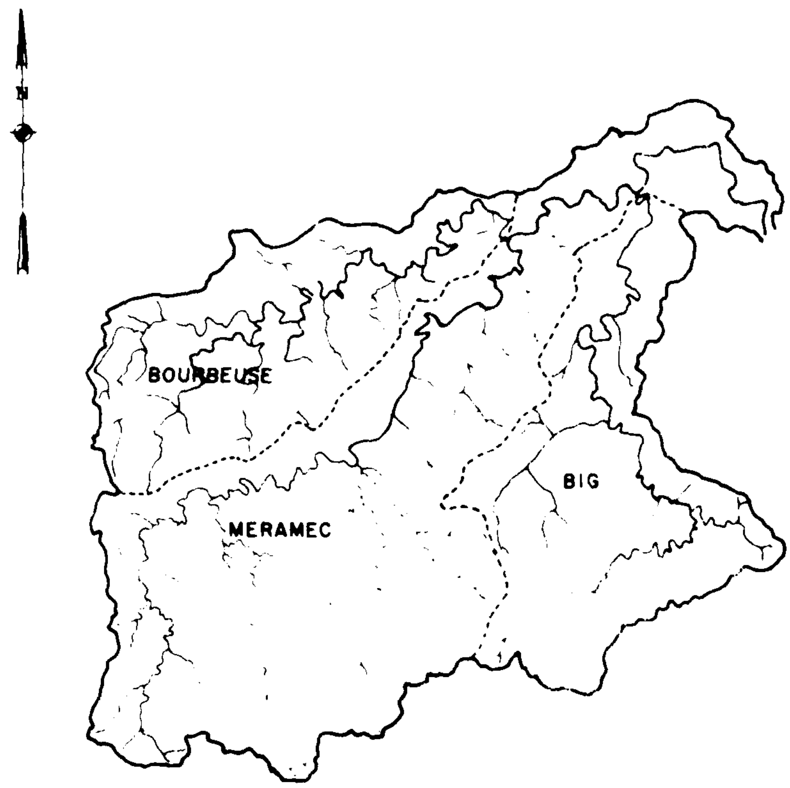


Figure 4. Kratz Spring.

Figure 5. Kratz Spring.

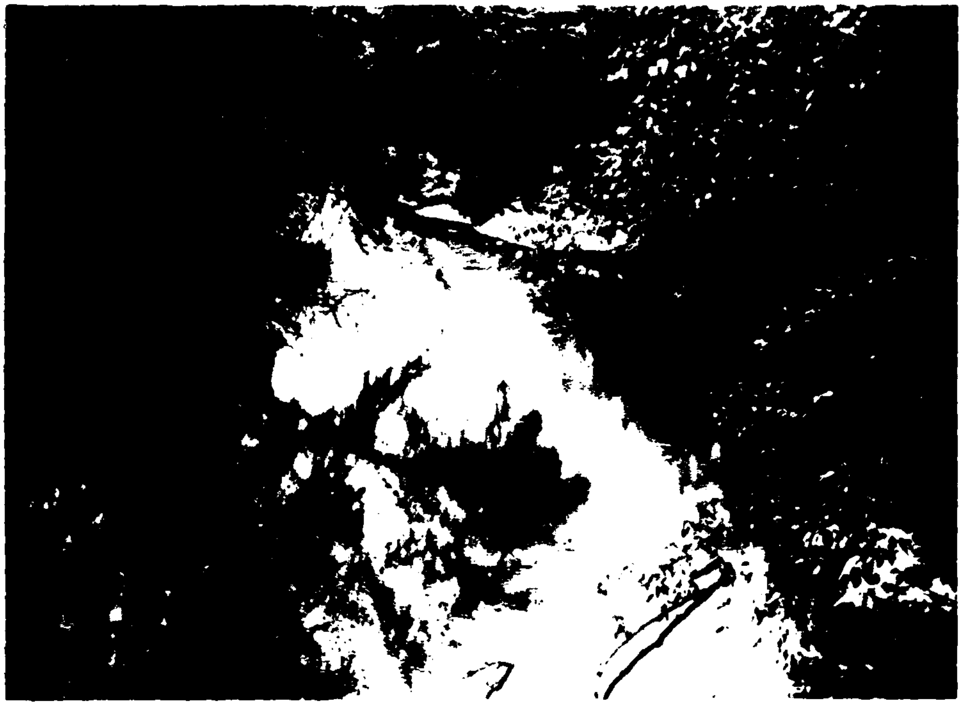


Figure 6. Typical pool on the Bourbeuse River.

Figure 7. Typical riffle area on the Bourbeuse River.

Figure 8. Good wildlife habitat along the Bourbeuse River showing an interspersion of forest, cropland, and annual weeds and grasses.

Figure 9. Interspersion of forest and fields typical of the Bourbeuse River Valley.

FIGURE 10—POPULATION TRENDS AND PROJECTIONS
FOR
FRANKLIN COUNTY, MISSOURI

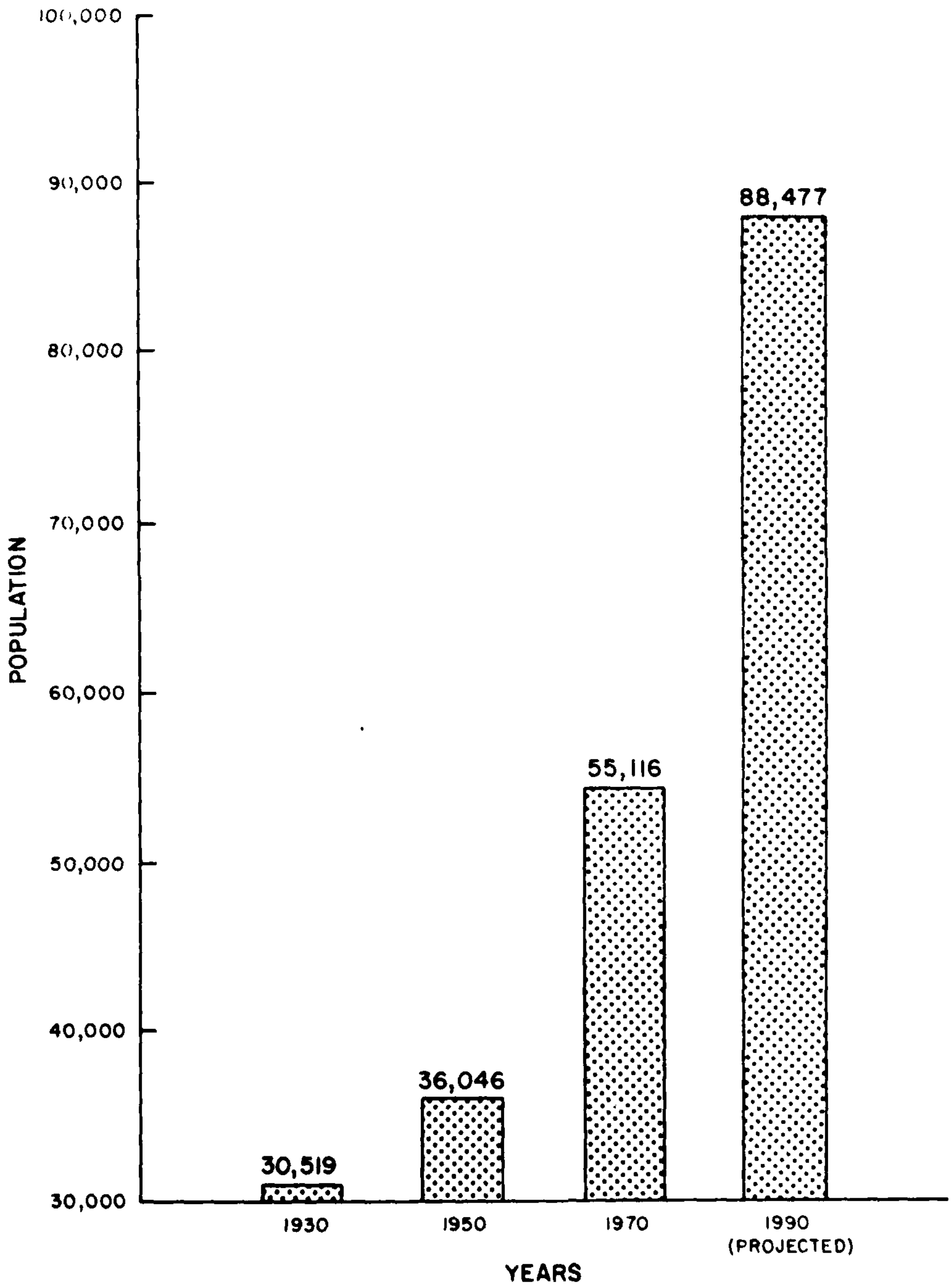
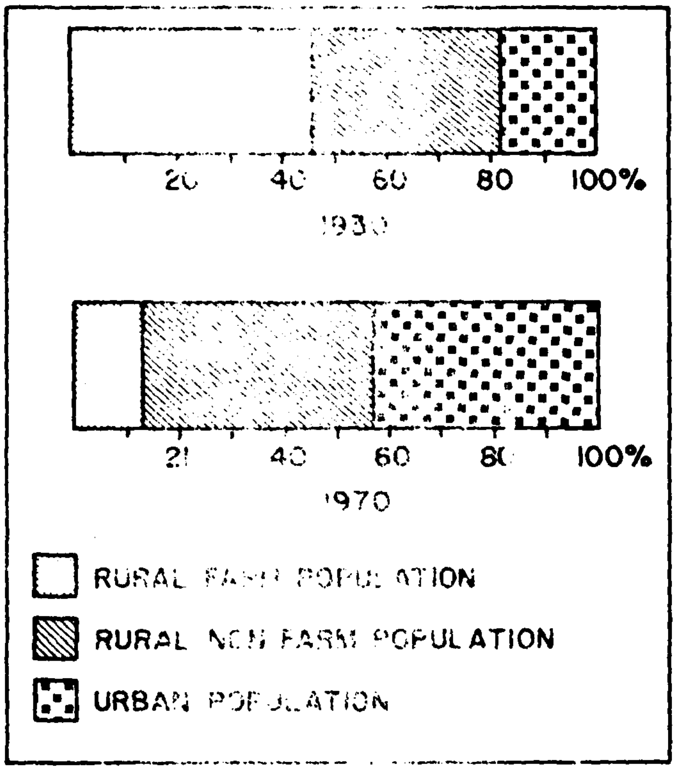


FIGURE 11 URBAN AND RURAL CHARACTERISTICS OF THE UNION LAKE AREA POPULATION 1930 AND 1970 FRANKLIN COUNTY



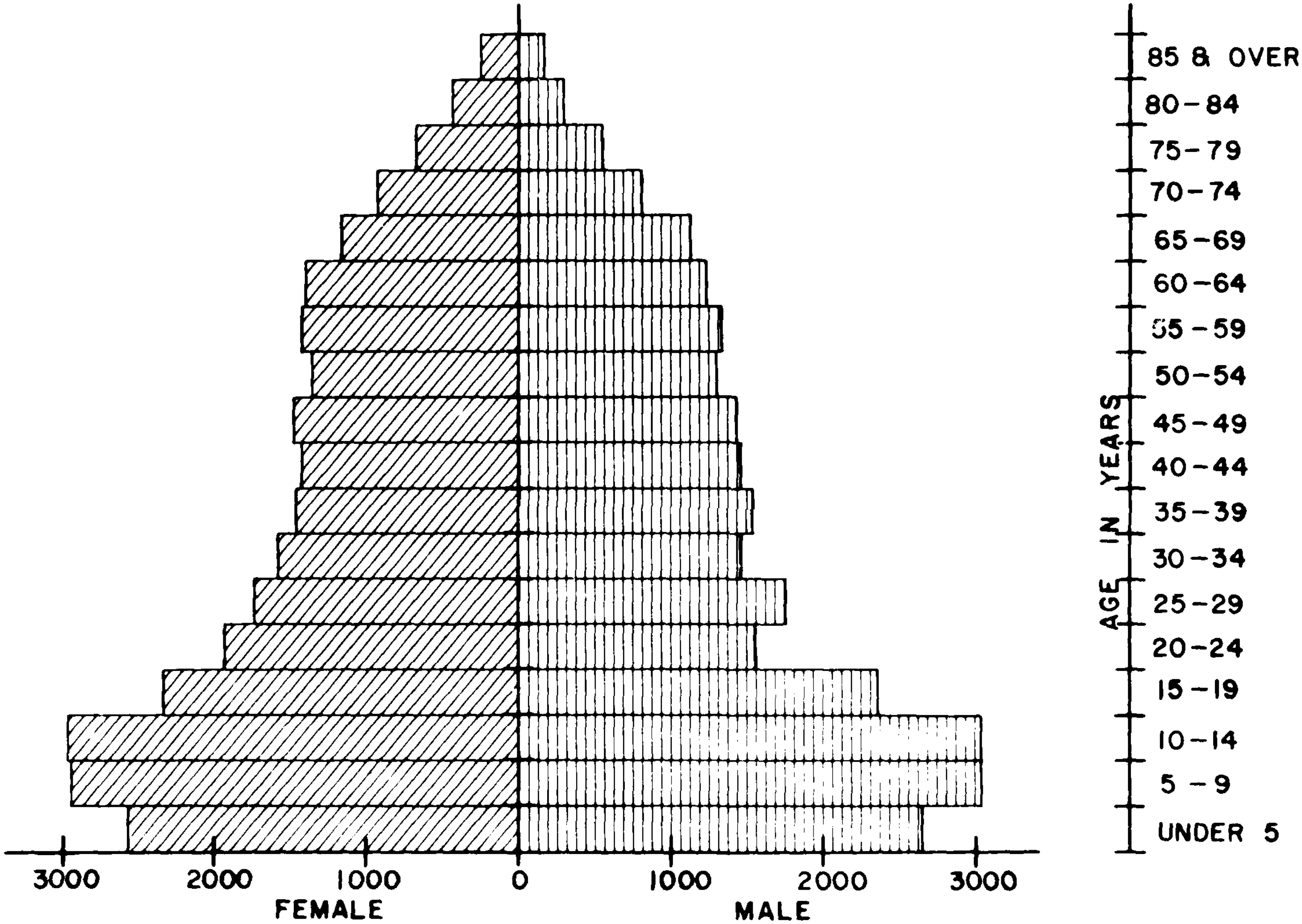
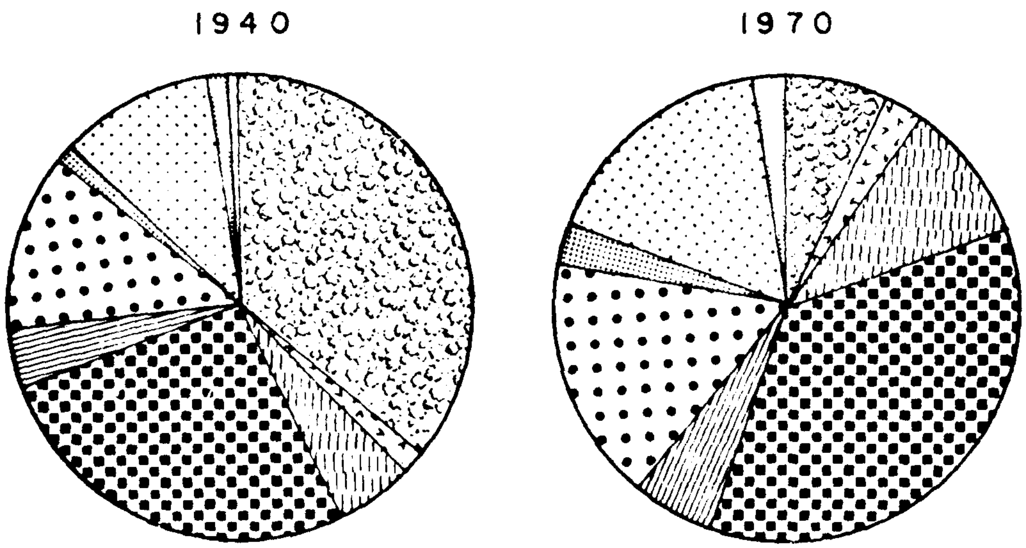


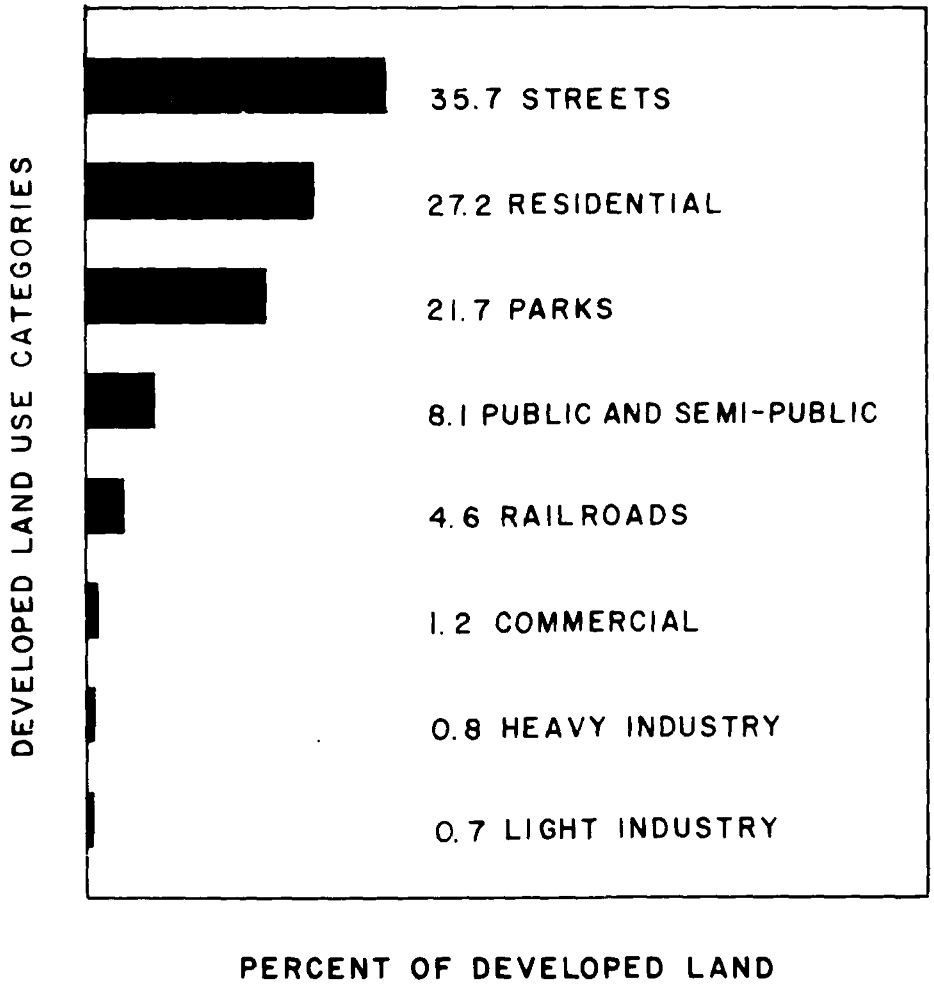
FIGURE 12 POPULATION PYRAMID FRANKLIN COUNTY, MISSOURI -1970

FIGURE 13 EMPLOYMENT BY INDUSTRY GROUP
FRANKLIN COUNTY, MISSOURI



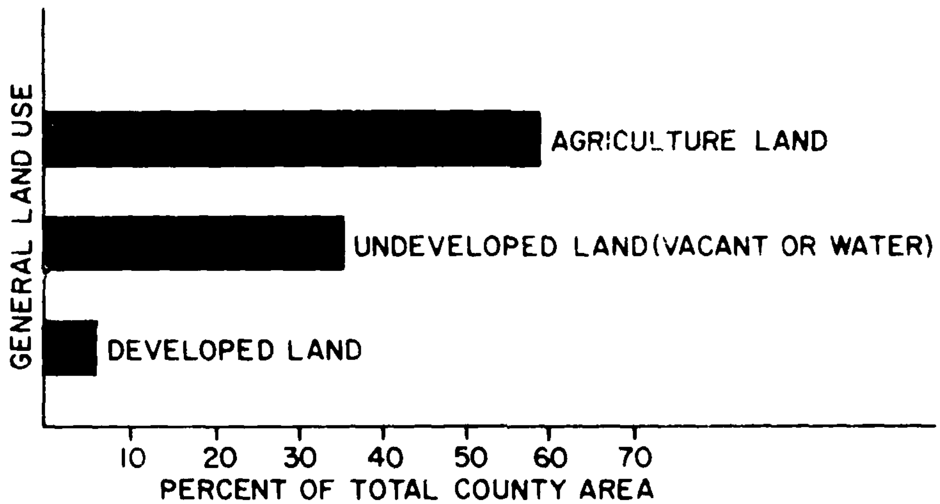
AGRICULTURE, FORESTRY AND FISHERIES
MINING
CONSTRUCTION
MANUFACTURING
TRANSPORTATION, COMMUNICATION, AND UTILITIES
WHOLESALE, AND RETAIL
FINANCE, INSURANCE, AND REAL ESTATE
SERVICES
PUBLIC ADMINISTRATION
OTHER

FIGURE 15 LAND USE IN FRANKLIN COUNTY, MISSOURI - 1968



Source: Harland Bartholomew and Associates, Field Survey, 1968.

F GURE 16 LAND USE COMPARISON, PERCENT OF DEVELOPED LAND IN FRANKLIN COUNTY, MISSOURI - 1968



Sources: Harland Bartholomew and Associates, Field Survey, 1968.

U.S. Bureau of the Census, <u>County and City Data Book, 1972</u> (A Statistical Abstract Supplement) U.S. Government Printing Office, Washington, D.C. 1973.

Figure [illegible]. Bluffs along the Bourbeuse River near Highway CC

Figure [illegible] [illegible] above the Bourbeuse River

Figure 21. Bourbeuse River Valley.

Figure 22. Large gravel bar along Bourbeuse River.

Figure 23. Scene along Bourbeuse River.

Figure 24. Scene of Bourbeuse River Valley near dam site.

3. RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

3.1 GENERAL

Despite the fact that Franklin County is in the path of St. Louis urban sprawl, land use ordinances are scattered and only a regional land use plan has been adopted.

3.2 PLANNING

The land use plan for the study area was produced by the East-West Gateway Coordinating Council in 1973 as part of the larger regional land use plan for the St. Louis Standard Metropolitan Statistical Area (Plate 1). The plan indicates that Franklin County will maintain its rural character with future urban development occurring in already existing towns, shown as free standing service areas and regional commercial centers. Recreational land is planned along the Meramec River and for a site which appears to be the proposed Union Lake project. Institutional and industrial centers are located at already existing facilities. Interstate 44 will remain to be the major highway for the county.

A comprehensive plan was designed by the Franklin County Planning Department in 1969. However, only the subdivision regulations have been implemented, the total plan has never been adopted. A revision of the 1969 comprehensive plan is currently under study.

3.3 ZONING

At present, there are no statewide planning and zoning codes for Missouri. Therefore, zoning in Franklin County is limited to that on the county and city levels. Zoning codes for Franklin County and its unincorporated areas include mobile home park and subdivision regulations, as well as a building code.

In Missouri, incorporated areas are not subject to county zoning regulations. Several of the major towns and cities in the Union Lake area lack zoning and subdivision codes. Gerald has neither type of code, while Union and St. Clair lack subdivision ordinances. Pacific and Washington have both codes in effect. These communities have a much higher population density than unincorporated areas; thus planning and zoning are especially desirable for efficient land use control.

3.4 COMPARISON OF THE PROPOSED PROJECT TO LAND USE PLANS

An examination of the regional land use plan shows no direct conflict by the proposed project. To the contrary, the planning agency appears to have had the proposed project in mind when drawing the plan. It would appear that Union Lake is expected to be a part of the recreation resource base for the St. Louis region.

3.5 COMPARISON OF THE PROPOSED PROJECT TO ZONING ORDINANCES

The proposed project does not directly conflict with existing zoning ordinances. However, possible impacts of the project such as population growth, urbanization, industrialization and recreation development may bring about indirect conflicts because of insufficient zoning and planning.

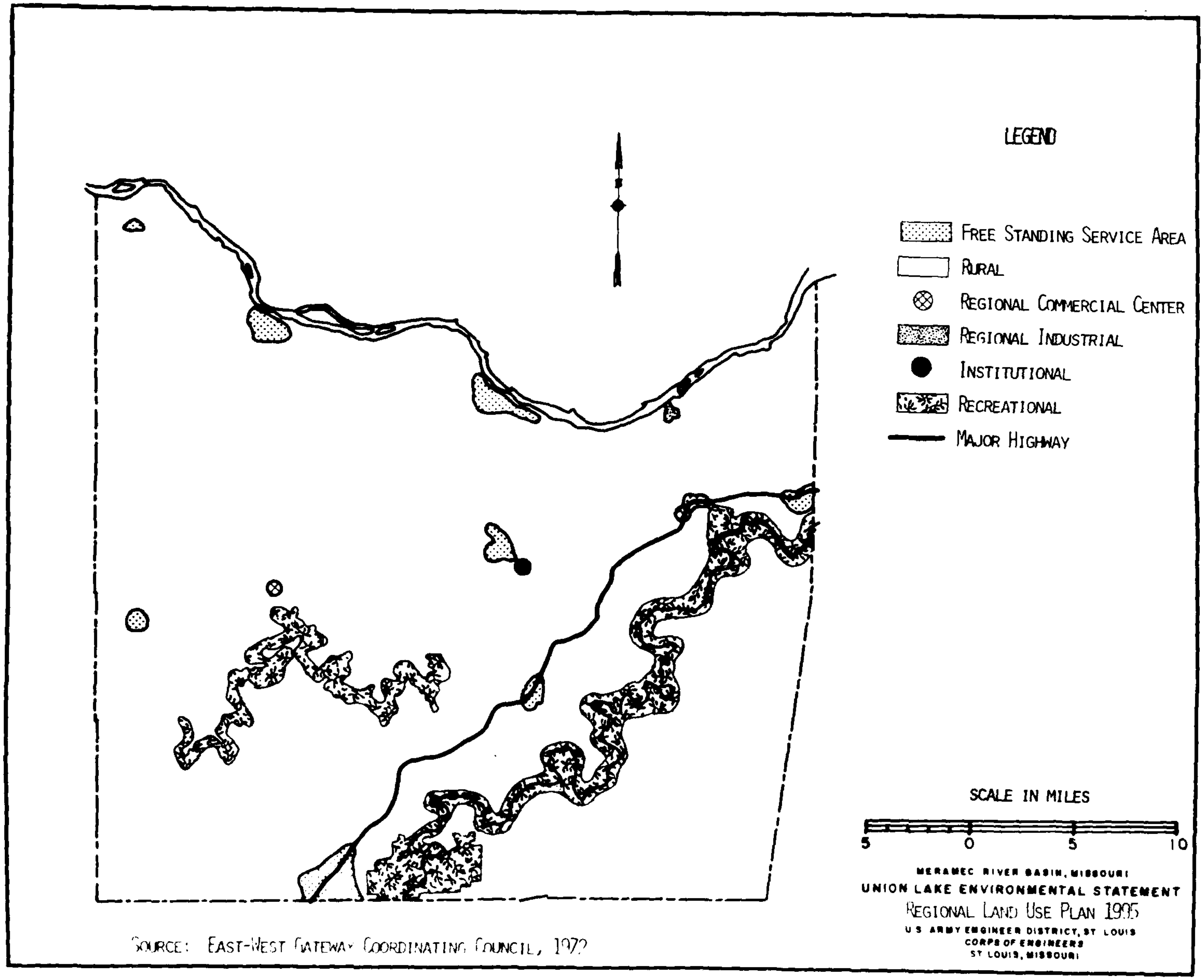

LEGEND
FREE STANDING SERVICE AREA
RURAL
REGIONAL COMMERCIAL CENTER
REGIONAL INDUSTRIAL
INSTITUTIONAL
RECREATIONAL
MAJOR HIGHWAY
SCALE IN MILES
5 0 5 10
MERAMEC RIVER BASIN, MISSOURI
UNION LAKE ENVIRONMENTAL STATEMENT
REGIONAL LAND USE PLAN 1995
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
SOURCE: EAST-WEST GATEWAY COORDINATING COUNCIL, 1972

PLATE 1

4. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

4.1 PHYSICAL IMPACTS

4.1.1 THE IMPACT OF CONSTRUCTION

Earthmoving and blasting operations, concentrated in the area of the dam, will be a source of noise, vibration, and dust for approximately two years. These operations will disturb some recreational pursuits in the vicinity, especially at the Ryker's Ford access. Construction of coffer-dams, borrow pits, haul roads, etc., will result in increased erosion and in the compaction of soils in the vicinity of the construction. Erosion will cause a temporary increase in the turbidity of the Bourbeuse River, and this is expected to have a temporary but adverse impact on the aquatic organisms in the river.

It is estimated that the maximum overall sound pressure associated with construction will be 65 db at a structure 0.25 miles away (the site of the nearest residence).

Reservoir clearing will result in temporary air pollution if burning is permitted. In addition to loss of wildlife habitat, and a resulting decrease in population size, some animals may be killed in the clearing operation.

Environmental protection provisions now incorporated into Corps of Engineers construction specifications are designed to limit these adverse effects to the maximum extent practicable. These specifications include provisions for prevention of water and air pollution, re-seeding of worked-out borrow areas, erosion control, and prevention of unnecessary damage to trees.

All contracts specify that contractors shall comply with all applicable Federal, State, and local laws and regulations concerning environmental pollution control and abatement. Waste disposal by burning is allowed for certain materials such as timber and brush, provided that such burning complies with Missouri Regulation S-III, Open Burning Restrictions. Before a contract is drawn up, the regional office of the Environmental Protection Agency will be consulted to determine local air pollution standards, and these will be included in the specifications.

4.1.2 POOL FLUCTUATION

Reservoir operation studies were based upon a 48-year period of record (1922-1969). Hypothetical reservoir pool elevations were developed from these data. These studies indicate that, if the project had been in place during the period of record, the maximum pool elevation that would have occurred would have been 650.8 feet m.s.l. During the flood of record, the lake's level would have been above the joint-use pool elevation for a total of 103 days during the recreation season. The minimum pool elevation during this 48-year period would have been 615.0 feet m.s.l. The average annual pool fluctuation would have been 8.3 feet, with a maximum of 32.2 feet and a minimum of 3.6 feet. Pool stage frequencies are shown in Figure 1. Table 1 indicates the acreage flooded at various pool elevations. The pool stage duration curve is presented in Figure 1A.

Most of the floods which produce high lake levels will occur during the months of March, April, May, and June, with the pool receding to joint-use pool elevation in July and then holding steady or falling slowly during the late summer and early fall seasons.

Droughts occurring during the summer recreation season would result in lower than joint-use pool levels, leaving a small portion of the lake bottom exposed. The water surface level can be expected to fall below the joint-use pool elevation once every 1.5 years, beginning in mid-July and continuing through late fall. A one-foot drop below joint-use pool elevation would expose about 146 acres around the lake. A two-foot drop would expose approximately 279 acres of lake bottom. Consequently, extensive "mud flats" will not be a significant problem at Union Lake.

Table 1. Union Lake acreage inundated at various pool elevations.

Elev. (ft.)	Initial Area (ac.)	After 100 Years Sedimentation Area (ac.)
610	5,369	5,207
611	5,521	5,359
612	5,647	5,485
613	5,788	5,626
614	5,913	5,751
615	6,048	5,886
616	6,176	6,014
617	6,306	6,144
618	6,433	6,271
619*	6,559	6,397
620	6,719	6,561
621	6,833	6,689
622	6,974	6,844
623	7,099	6,983
624	7,239	7,130
625	7,475	7,380
626	7,692	7,611
627	7,902	7,828
628	8,094	8,020
629	8,288	8,232
630	8,472	8,423
631	8,664	8,622
632	8,829	8,787
633	9,023	8,988
634	9,201	9,173
635	9,387	9,362
636	9,569	9,548
637	9,742	9,728
638	9,918	9,911
639	10,108	10,108
640	10,287	10,287
641	10,474	10,474
642	10,656	10,656
643	10,843	10,843
644	11,127	11,127
645	11,213	11,213
646	11,397	11,397
647	11,586	11,586
648	11,783	11,783
649	12,136	12,136
650	12,462	12,462
651	12,863	12,863

*Joint-use pool
Reference: US Army Corps of Engineers, St. Louis 1969

4.1.3 THE IMPACT OF SEDIMENTATION ON UNION LAKE

The 100-year sediment storage at Union Lake is computed to be 13,700 acre-feet. Total storage below the top of the joint-use pool is 160,500 acre-feet. Based upon the present rate of sedimentation, sufficient storage volume has been provided that all project functions will continue for 100 years before impairment of these functions will begin. The lake will eventually fill with sediment; however, if the rate of sediment yield remains constant in the future, approximately 1100 years of deposition could occur before the joint-use purposes of the project could not be met. The rate at which the reservoir receives sediment is directly related to rainfall-runoff experienced in the Basin. Accepting the 100-year volume, the long-term average annual rate of sedimentation would be 182 acre-feet per year. This volume is distributed from the maximum elevation the reservoir attains in a year, down to the existing channel invert of the damsite.

Sediment begins to deposit when the velocity of the stream decreases. When the free flowing stream enters the reservoir, the velocity approaches zero. Therefore, bedload and coarser particles of the suspended load begin to form deltas. The finer grained material moves into the reservoir until the velocity decreases below that required to keep the material in suspension. The very finest grained material will eventually settle out near the dam, or be passed through the outlet works. The location of sediment deposition depends on the reservoir pool fluctuation and will continually change. With the small amount of average annual sediment expected to enter the reservoir through pool fluctuations and floods on tributaries, it is impossible to state a rate at which deposition will occur at any specific elevation.

4.1.4 WATER QUALITY

4.1.4.1 General

The water quality of the rivers and tributaries in the Meramec Basin is discussed in paragraph 2.1.3.3.

4.1.4.2 Water Quality in Union Lake

The overall quality of the water in Union Lake will be good. During initial filling, the biochemical oxygen demand generated by the decomposition of inundated vegetation will lower oxygen levels in some areas of the lake. As filling progresses, and in subsequent years, this will become less of a problem.

The lake will tend to equalize the quality of the water with respect to pollutants. Inflows of variable quality will be diluted by the lake water and produce outflows of more constant quality.

Stratification refers to the layering of water of different densities (in this case, based on temperature) in a lake. Thermal stratification of Union Lake will occur during the summer and possibly during the winter months. Normal lake turnover will result in complete mixing of all waters in the lake.

Carbon dioxide, pH, alkalinity, and hardness in the lake water are largely determined by inflow water quality, the character of the lake, soils, and biological activity, which in turn are largely influenced by thermal stratification and its effect upon oxygen conditions. During stratification, the deeper layer (hypolimnion) will develop higher concentrations of carbon dioxide, lower pH, decreased dissolved oxygen, increased hardness, and higher values of specific conductance than the upper layer (epilimnion).

The turbidity of inflowing waters will be reduced in the lake because of decreased longitudinal velocity. The highest turbidity will occur during storm runoff and will persist for only short periods of time. The main pool of the lake will remain clear due to the long retention time of water in the lake. High inflows are impounded in the 'flood control pool' prior to downstream release, allowing for settlement of incoming sediment. Sedimentation will cause reductions in the water storage capacities and produce silt deposits in localized areas of the lake. [illegible] of the incoming water will occur during storage. [illegible] will be greater in the lake during filling but will decrease in subsequent years.

The bacteriological effects of the lake will be generally beneficial in that bacterial concentrations are significantly reduced during storage. Fecal coliform bacterial levels presently range from less than 5 to 1,400 counts per 100 ml. in the Bourbeuse River. Missouri water quality standards limit fecal coliform concentrations to less than 200 counts per 100 ml. for whole body contact recreation. As the higher bacterial concentrations occur infrequently and usually during storm runoff, and because of the beneficial action of the reservoir, bacterial levels should be substantially below current state standards.

Tastes and odors in the lake may develop due to hydrogen sulfide produced in the hypolimnion or from organic extracts and secretions from living or decomposing algae. Hydrogen sulfide will be present during the first few years after the lake fills, but will dissipate as the lake ages. Present levels of phosphorous and solids were high in some areas. These values exceeded those generally recognized as the minimum levels above which troublesome algae blooms develop. These algae blooms will increase any taste and odor problems related to the lake. The potential for higher productivity in the lake will be enhanced by the retention of these nutrients.

Eutrophication is a term applied to the aging of a lake through the accumulation of organic and inorganic sediments. Eutrophication of Union Lake will be accelerated principally by nutrient enrichment as a result of organic decomposition in the lake and pollution from external sources. Algae production will be stimulated somewhat as a result of the

decomposition of organic matter and the subsequent release of nutrients. Sources of organic pollutants in the Union Lake area include septic plants, municipal treatment plants, sewage lagoons, clubhouses, and industrial processes, plus agricultural activities. However, these sources are widely scattered throughout the area and the total impact should not be very significant. Additionally, the enforcement of Federal laws pertaining to cleaning of the nation's waterways should further alleviate the problem of eutrophication of Union Lake.

A summary of beneficial and detrimental effects of Union Lake are listed as follows:

a. Beneficial Effects:

(1) Reduction of turbidity, silica, color, and coliform bacteria.

(2) Sharp variations in dissolved minerals, hardness pH, and alkalinity are lessened to approximate constant levels.

(3) Entrapment of sediment.

b. Detrimental Effects:

(1) Increased algae growth which may cause taste and odor problems and eutrophication.

(2) Reduction of dissolved oxygen in the deeper parts of the lake.

(3) Increase in carbon dioxide and frequently iron, manganese, and alkalinity, especially near the lake bottom.

(4) Increase in dissolved solids as a result of evaporation and dissolution of rock materials.

4.1.4.3 Water Quality Impacts on Union Lake Below Dam

A water quality control weir will be located upstream (about 500 feet) of the dam with a spillway crest at elevation 599. feet m.s.l., 20 feet below the normal pool of 619. The weir will function much like the weir in the dam at Meramec Park Lake, where approximately 93 percent of the water released will be from the epilimnion and the remainder will be from the thermocline and hypolimnion. Since most of the water will be drawn from above the thermocline, the water released downstream through the control structure will be of a similar quality to that which presently exists in the Bourbeuse River. The water will generally be high in oxygen, extremely clear, and have temperatures similar to those which presently exist.

Downstream releases will be lower in bacterial levels, and these releases will tend to be more uniform in quality than under natural conditions. The ability of the lake to eliminate sharp variations in dissolved minerals, pH, hardness, and alkalinity will result in a better water quality in the downstream release. During flood periods, water impounded will be held long enough so that much sediment will have settled and large concentrations of organic or inorganic matter will have been diluted prior to downstream release.

Stratification of the lake may cause downstream problems if certain conditions exist. A pollutant entering the lake will settle into the layer of water of an equal density. There is a possibility that such an effluent could layer into the upper twenty feet of the lake and be pulled over the weir and discharged directly downstream. Under these conditions, the downstream release would be of lower quality; however, this is not expected to be a problem at Union Lake because of the dilution potential of the lake.

Downstream flow will be augmented during low flow periods and confined within the banks during periods of high water, thus alleviating the extreme conditions that normally occur during the course of a year This relative stability should benefit most forms of aquatic life now inhabiting the river. A decrease in turbidity in the downstream releases will increase the zone of light penetration, and the reservoir release should contain sufficient nutrients and organic material to maintain approximately the same level of productivity that now exists in the river.

4.1.4.4 Water Quality Investigation Program

Water quality changes resulting from dam construction, land use changes, and lake filling will be continuously monitored at Corps of Engineers water quality sampling sites located above and below the proposed dam. Monitoring will occur monthly to determine the physical, chemical, and biological conditions. This investigation program will continue indefinitely after full impoundment to determine if degradation in the stream or lake occurs. A program of this type will provide a warning of detrimental effects and pinpoint any possible causes of degradation. Analysis of water quality data throughout the construction and operation of the project will aid in making changes, if required, in the operation or future design of dam projects.

4.1.5 THE IMPACT ON SOILS

4.1.5.1 General

The reader is directed to paragraph 2.1.2.3 for a discussion of soils in the project area.

4.1.5.2 Upland Soils

a. Union Soils: The shoreline of the lake will rest almost entirely on weathered Union soils. However, as the project will lie chiefly within narrow valleys, for the most part surrounded by hills, the shoreline will lie principally upon the more weathered Union soils. Since these are the more residual materials, wave action should not be severe and shoreline erosion should be minimal.

The Union soils are generally classed by the Extension Division, University of Missouri, as Classes 4 and 6, i.e. inferior cropland and marginal pasture/forest land.

b. Lebanon Soils: Surface erosion of the Lebanon silt loam should not be complicated by the proposed lake since these soils are somewhat removed geographically from the lake site itself.

4.1.5.3 Bottomland Soils

Huntington Soils. The bottomland soils in and below the project area belong to the Huntington Group, and are considered good agricultural soils. These soils would be inundated in the project area.

4.1.6 THE IMPACT ON MINERAL DEPOSITS

4.1.6.1 General

The reader is directed to paragraph 2.1.2.2 for a discussion of mineral deposits in the project area.

The 1962 "acquisition policy" will be implemented with respect to the acquisition and/or subordination of minerals by a strict interpretation i.e., generally, fee title to all subsurface interests will be acquired in areas required for all structures, are required for project operations and public use, including access, and in areas where the value of mineral interests is nominal. The reservation of mineral rights, where development will not interfere with project purposes, will be predicated upon the Governments's right to regulate their development as to eliminate any interference with project purposes and to minimize any adverse impact on the environment, including aesthetic values.

4.1.6.2 Sand and Gravel Deposits

Gravel deposits of the Bourbeuse River Valley are the result of erosion from higher elevations and deposition in the valleys. After these deposits reach the valleys, they are gradually worked downstream by water currents. Since the dam would be a barrier to the downstream movement of the deposits, the amount of gravel transported downstream of the dam would slow the downstream movement of the gravel deposits existing below the dam.

The impact on the sand and gravel resource will result from the direct inundation of sand and gravel in the project area, and from a retardation of sand and gravel replenishment downstream of the reservoir. However, the poor quality of the sand and gravel deposits in the project area, due to their high chert content, makes them of questionable economic value.

4.1.6.3 Fire Clay Deposits

Fire clay deposits occur as sinkhole fillings scattered throughout the uplands near the project area. No known fire clay deposits will be affected by the reservoir; however, it is possible that undiscovered deposits may be inundated.

4.1.6.4 Rock Quarries

Some rock suitable for building stone or crushed stone occurs in areas which would be inundated or affected by changed groundwater conditions. One continuous commercial quarry operated by Weber Construction Company is known to exist. However, equally or better suited sites which will be unaffected by the project, occur in the area and will more than adequately furnish the projected demands for stone in this area.

4.1.6.5 Iron Ore

Iron ore occurs in the project area as both deep seated Precambrian hydrothermal deposits and shallow filled sink deposits. The filled sink deposits consist of limonite and hematite caking iron sulfide deposits of pyrite and marcasite. One such mine, the Lislie, will be inundated; however, it has been abandoned since 1937. No other filled sink mines are presently in operation and no known economic prospects will be inundated. Precambrian iron deposits consisting of economically valuable magnetite occur within the project area. These deposits lie several thousand feet below the surface and thus would be unaffected by the reservoir.

4.1.7 THE IMPACT ON FLOODING

4.1.7.1 General

The reader is directed to paragraph 2.1.3.2 for a discussion of flooding in the project area.

4.1.7.2 Union Lake to Confluence of Bourbeuse River

The Union Lake will control about 20 percent of the runoff from the Bourbeuse River watershed and release a maximum of 4,000 c.f.s. Consequently, the extent of flooding downstream of the dam will be reduced. Table 2 shows flood reduction potential of Union Lake at a point just downstream of the confluence of the Bourbeuse and Meramec Rivers.

Table 2 Flood reduction potential of Union Lake below the confluence of Meramec and Bourbeuse Rivers.

Frequency of Flood Once in Years	Discharge Without Union Dam	Discharge With Union Dam	Reduction of Flood Depth with Union Dam
13	81,800	61,800	4.5
60	136,300	101,300	2.6

This reduction of flood depth due to retention of flood waters by the Union Dam and containment of river flows within banks, will afford virtually complete protection to 7,020 acres of bottomland lying along the river between the damsite and the confluence of the Bourbeuse and Meramec Rivers.

4.1.7.3 Confluence of Meramec and Bourbeuse Rivers to Mississippi River

Below the confluence of the Bourbeuse River, Union Lake will reduce flood damage. Table 3 shows the flood depth reduction potentials at the Eureka Index gage for Union Lake.

Table 3 *Flood reduction potential at Eureka, Missouri.*

Frequency of Flood Once in Years	Eureka Discharge Without Union Dam	Eureka Discharge With Union Dam	Reduction of Flood Depth With Union Dam
13	101,000	85,000	2.0
60	168,250	139,200	1.2

This reduction of flood depth will provide partial protection to 21,290 acres of bottomland in the lower Meramec Valley between the confluence of the Bourbeuse and Meramec Rivers and the confluence of the Meramec and Mississippi Rivers.

4.1.8 THE IMPACT ON SEISMIC ACTIVITY

A review of case histories of the connection between reservoir filling and seismic activity indicates that such phenomena have occurred (1) where a crustal block was already strained to near-yield but was in delicate equilibrium; (2) the size and height of the reservoirs were of a much larger order of magnitude than Union Lake (Carder, 1970).

There is no evidence of major active faulting in the vicinity of Union Lake, although considerable seismic activity has taken place in areas around the Basin (see PART TWO, PLATE 7). The Leasburg fault, crossing the central part of the lake, was near the epicenter of an earthquake in 1943 with an intensity between 4 and 5 on the Modified Mercalli scale. This is an intensity that will break some dishes and windows and cause a few cracks in plaster. No surface movements of the fault have been observed.

The first documented instance of seismic activity in connection with reservoir filling in the United States was that of Lake Mead, where numerous small shocks were felt during reservoir filling, culminating in a magnitude 5.0 shock when the reservoir had reached 80 percent capacity. No damaging earthquake occurred. Geologic investigations revealed the area was broken up by countless minor faults. With a reservoir water mass of [illegible] million tons, Lake Mead is approximately 60 times as large as Union Lake; with a depth of over 300 feet, it is about twice as deep as Union Lake and three to four times as deep as the portion of Union Lake crossing the Leasburg fault. It is stated by Professer Rothe in Carder's paper regarding earthquakes adjacent to six reservoirs throughout the world: "The earthquake activity is particularly clear when the reservoir is deeper than 100 meters (approximately 300 feet). The height of the water seems to be more important than the total volume of the reservoir .... Some particular geological conditions are necessary for release of the shocks ... in many cases the filling of the reservoir did not bring any notable seismic activity."

It should be noted that at [illegible] reservoirs comparable to Union Lake have been built in the surrounding area (Barkley, Kentucky Lake, Norfork, Bull Shoals, Table Rock, Clearwater, Wappapello, Stockton, Pomme de Terre, and Lake of the Ozarks) and no increased seismic activity that can be associated with the filling and lowering of these lakes has been observed. It is highly unlikely that any increase in seismic activity would ever be associated with the Union Lake project. (For further discussion of seismology of the project area, refer to paragraphs 2.1.1 and 2.1.2.1.

4.1.9 THE IMPACT ON GROUNDWATER

4.1.9.1 General

The reader is directed to paragraph 2.1.1 for a discussion of groundwater in the project area.

4.1.9.2 Groundwater Levels

Groundwater rises in a relatively uniform manner with increasing distance from the river and its tributaries. The levels were determined from the study of 243 wells and drill holes in preparation of Design Memorandum No. 3, Site Geology (U.S. Army Corps of Engineers, St. Louis, 1970). The groundwater elevation is primarily dependent upon distance to the stream it feeds and relatively independent of ground surface irregularities and rock type. Seasonal fluctuation near the dam site has been found to be negligible.

After the lake is filled, groundwater levels will rise because the lake surface, rather than the Bourbeuse River surface, will become the lower limit of the groundwater elevation. With a few exceptions the existing groundwater elevations in the reservoir divides are above the proposed pool elevations (619 feet m.s.l. normal pool and 651 feet m.s.l. flood control pool) and groundwater flow will still take place from the divides toward the lake; thus, there will not be leakage away from the lake. The new groundwater level at rhe shoreline will be coincident with the lake level, with the amount of groundwater rise decreasing proportionately with increasing distance away from the lake level and toward the divide. Two low groundwater gaps, possibly caused by heavy pumping of water wells, exist in the divides which may require remedial treatment to prevent leakage; however, the reservoir will retain water to the degree required by project purposes.

Due to the rather steep and rugged topography of the area, the groundwater level is rather deep beneath the uplands that will be above the proposed lake. Although groundwater levels will rise, the resultant levels will still be rather deep. Thus, no significant problems such as septic tank problems, wet basements, marshy lands, or other problems frequently associated with groundwater rises are expected to occur. One beneficial aspect may be the increased productivity of wells in areas near the lake.

4.1.9.3 Groundwater Pollution

Impoundment of the lake will undoubtedly result in an influx of residential - recreational - commercial development, including motels, summer homes, resorts, restaurants, service stations, and other tourist-related developments; together with these developments will come the need to dispose of their sewage and solid waste.

The soils adjacent to Union Lake are fairly permeable. While soil of this type is looked upon as attractive for septic tank construction, such treatment is not suitable in any but a very sparsely populated area. Although the permeability of the sandstone is good, the principal water-

bearing rocks (limestones and dolomites) in the area are in themselves not very permeable, and owe their ability to transmit water to numerous fractures, bedding planes, joints, and solution channels that provide little natural filtering action. The result of the soil and rock properties is that polluted water entering the ground from septic fields, damaged septic tanks, leaking sewage lagoons, and improperly controlled treatment plants, and landfills could conceivably travel distances unaltered and result in pollution of water wells and/or surface water. Proper regulatory controls on removal and treatment will be necessary to prevent the pollution of Union Lake. Sewage treatment on project lands will be designed to meet all applicable standards. Regulatory controls outside of project lands are the responsibility of state and local governments. Waterborne sewage collection with centralized treatment is the only positive approach to pollution prevention.

There is one instance in which pollution could be transmitted from the lake to the groundwater, that is, if water wells are installed sufficiently close to the lake and pumped in sufficient quantity that their drawdown water level is lower than the lake level. In this case, pollutants that may be in the lake would be drawn into the groundwater system.

In summation, proper regulatory control of sewage and fresh water systems is necessary to provide a high degree of protection against pollution of groundwater and surface water adjacent to Union Lake in light of the anticipated development.

4.1.9.4 Local Slumps, Sinks, and Collapse Structures

Due to the permeability of the soil and competency of the rock, slopes in the Union Lake area are generally stable. Even though the impoundment may cause minor slumps or small slope failures, no major or significant landslides are expected as a result of the project. Minor areas of slope instability would be possible around the reservoir edges due to the changed water levels and fluctuations.

Changes in groundwater movement characteristics and static water levels could cause changes in underground erosion and solutioning, and such changes might result in the development of sinks or other collapse structures and associated unstable ground. These developments may not take place, but if they do, it would be to a very minor extent since the processes involved normally act over long periods of time (thousands of years) before producing significant results. Previously formed solution zones in areas where solution activity would be significantly increased by impoundment would be necessary for the formation of new sinks or other collapse structures attributed to the project.

4.1.9.5 Leakage

The existing groundwater table in the project area is tributary to the Bourbeuse River and will be tributary to the lake after it is filled. The water table generally rises on a gentle slope from the river surface

to elevations above the proposed reservoir levels (619 feet m.s.l. normal pool, 651 feet m.s.l. flood control pool) in the divides. Except for two cases, this situation precludes leakage to adjacent drainage basins. These two low groundwater gaps in the divides may require remedial treatment to prevent leakage; however, the distance of these gaps from the lake and the slowness of groundwater movement insures that the lake will retain water to the degree required by project purposes. After the lake is filled, groundwater levels will rise on a flatter gradient from the lake level to the groundwater divides. The water levels will be raised by the impoundment a maximum of about 100 feet near the river, generally diminishing to no change within a few miles.

It is possible that heavy pumping of water wells near the divides could lower the water levels, in their area of influence, to elevations below the lake level. If this happens, the cones of depression in the water table caused by the wells may be recharged by the lake. In this case, any pollutants that may be in the lake may be drawn into this groundwater system.

PART TWO, Plate 7, shows one significant fault in the area, the Leasburg Fault. Its possible influence on reservoir leakage has been examined. Water wells near the fault exhibit static levels as high as those in other wells at some distance from the fault, indicating that the fault zone is not acting as a drain for groundwater.

The possibility of solutioned zones causing leakage to adjacent drainage basins is not expected. Most of the caves in this area are of limited lateral extent and generally slope upward toward the divides, approximately parallel to the water table. Solution activity normally decreases with depth below the water table.

Reservoir leakage downstream from the dam will be precluded by proper design and construction of the project. Extensive grouting for this purpose has been included in the project design.

4.1.10 THE IMPACT ON CAVES AND SPRINGS

There are approximately 3,000 caves known in the State of Missouri (Aley, pers. com.), approximately 150 of which are known from the Meramec Basin (Ryckman, et al., 1973). Three caves will be inundated by the normal pool, and an additional two caves will be periodically inundated by flood pool (see Table 3a).

Three out of 88 springs known in the Basin will be affected by the Union Lake. One at normal pool, and two periodically by the flood pool. These springs are listed in Table 3b. All of these springs have an average flow of less than 15 c.f.s.

The geological development of caves, as well as the discharge rate and quality of springs, may be affected by the higher water levels within a distance of about 2 miles from the lake. The expected changes would be

of minor consequence in a limited area. Anticipated changes in the water quality of springs are considered negligible.

Active geological development of caves in this region is normally attributed to the zone at or just below the groundwater table. By raising the water level, this development will naturally rise a like amount. It should be noted that normally it takes thousands of years for natural geologic processes to form a major cave.

Table 3a Caves that will be affected by Union Lake

Name of Cave	County	Location
Noser Cave F (or Quarry Cave)	Franklin	Sec 17, T42N, R2W
Lead Caves N	Franklin	Sec 30, T42N, R1W
Mine Cave N	Franklin	Sec 3, T42N, R1W
Molitor Caves F	Franklin	Sec 24, T42N, R2W
Weber Quarry Cave N	Franklin	Sec 31, T42N, R1W

N - *Cave falls in normal pool*
F - Cave falls in flood pool

Table 3b Springs affected by the Union Lake.

Name of Spring	County	Location
Kratz N	Franklin	Sec 21, T39N, R2W
Little Creek F	Franklin	Sec 24, T40N, R2W
Roaring F	Franklin	Sec 30, T40N, R1W

N - Spring falls in normal pool
F - Spring falls in flood pool

4.1.11 IMPACT ON STREAMS

Approximately 50 miles of rivers and creeks will be permanently inundated. Thirty of these 50 miles of streams are large enough to be considered floatable by canoe. Regardless of size, all characteristics which distinguish streams from lakes will be lost due to inundation. Up to an additional 30 miles of streams will be inundated by the flood pool. Twenty-five of these 30 miles are considered floatable. The physical characteristics of the streams in the flood pool should not be greatly altered.

In the event that the spillway would have to be used, up to 85,700 c.f.s. would be released down a natural ravine for about 1,400 feet, then into Voss Creek for about 3,000 feet and then into the Bourbeuse River at Reiker Ford. This sudden flow of water would cause erosion in the creek valley that may be severe enough to dislocate trees. The eroded soil would flow into the river below the dam and increase the turbidity. It is possible that small animals may get caught in the water and be killed. In addition, the access road to the dam site from the west would be inundated where it crossed Voss Creek.

4.1.12 IMPACT ON BOURBEUSE RIVER FLOW AND CHANNEL MORPHOLOGY BELOW THE DAM

Union Lake Dam will, generally, affect river flows below the dam in two ways; below the dam "out of bank" flows will be virtually eliminated but one-half to full bankfull flows would be maintained for several weeks after each flood. During the dry (August - September) months extreme low flows (13 c.f.s. and below) will be eliminated. During the other 8 or 9 remaining months of the year, flows below the dam will be almost identical to natural conditions. A more complete discussion on downstream flows after construction of the dam is found in paragraphs 1.9.2 and 1.9.4.

The virtual elimination of floods in the reach immediately downstream of the damsite and the reduction of flooding in the lower reaches will have some effect on the river's regime. The rate of migration of the pools and riffles, i.e., gravel bars, will decrease due to the reduction in the frequency of occurrences of the larger flood-like discharges. In addition, the lesser rate of pool migration will result in a reduction in the amount of river bank caving which is usually present on the concave side of a bend adjacent to a deep pool.

The releases at the damsite after Union Lake has been filled to its normal pool will approximate its present average annual streamflow of 617 c.f.s. It is felt that little change in the river's regime will result upon completion of the project since the average annual discharges will not be changed significantly.

The control of flooding on the river may permit increased vegetation on the sandbars due to less frequent inundation. This may have an adverse recreational impact for those canoeists who use these sandbars for picnicking and camping. It is noted, however, that there will still be bankfull flows which will tend to erode the headward ends of the bars and deposit sediment over the remaining portions of the bars, thus offsetting the tendency toward sandbar stabilization by increased vegetative growth.

4.2 BIOLOGICAL IMPACTS

4.2.1 IMPACTS ON AQUATIC ORGANISMS

4.2.1.1 The Impact of the Project on Plankton

The effect of impoundments on plankton populations is incompletely understood. Hudson and Cowell (1966) stated that phytoplankton populations usually increase after impoundment of a river, due to the reduction of current and associated turbidity levels. Applegate and Mullan (1967) found that phytoplankton and zooplankton populations were more diverse in a new Ozark reservoir, as compared to an old reservoir. Luferova (1968) found that the zooplankton species diversity increased during the first year of the reservoir, but then began decreasing after that time. He also found a rapid increase in biomass. Luferova found that rotifers were the dominant river plankton, and crustaceans were the dominant plankton in the reservoir. Rodhe (1964) reported that primary production increased in a new reservoir in Sweden prior to full impoundment. After full impoundment, the standing crop and the production of algae and zooplankton increased.

Based on our knowledge of the behavior of plankton populations in reservoirs, it is difficult to make a quantitative prediction of what effects Union Lake will have on the present plankton populations in the Bourbeuse River. From the above studies, it may be generally concluded that the impoundment of the Bourbeuse River will result in an increase in the standing crop and production of both phytoplankton and zooplankton. The reservoir will also alter the species composition of the plankton population, and will probably result in a decreased species diversity after the new reservoir has reached a state of equilibrium.

The reader is referred to paragraph 2.2.3.2 for a discussion of plankton in the Meramec Basin.

4.2.1.2 The Impact of the Project on Benthos

a. General. The reader is referred to paragraph 2.2.3.3 for a discussion of Benthos in the Bourbeuse River. The effect of impoundments on benthic invertebrates has been well documented. Cowell and Hudson (1968) reported that the standing crop of benthos increased in a Missouri River reservoir, due to the increase in suitable habitat. Aggus (1970) found that chironomids became the dominant organism of the benthos in a new Ozark reservoir. O'Connell and Campbell (1953) studied the benthos of the Black River, Missouri, before and after it was impounded to form Clearwater Lake. Marked changes associated with inundation included: (1) a significant decrease in number of taxonomic groups; (2) a change in dominant organisms from midges, mayflies, and riffle beetles to midges, mosquitoes, and oligochaetes; and (3) a slight numerical increase in standing crop. Trends within the reservoir included a gradual increase in standing crop and a gradual decrease in the total number of common benthic groups. Isom (1971) states that studies have shown benthic macroinvertebrates may be limited by

siltation, rheotactile deprivation, water level fluctuation, hypolimnetic oxygen deficiency, increased hydrostatic pressure, [illegible] impoundment associated factors. He has shown that virtually all benthic fauna has been eliminated from storage impoundments in the Tennessee Valley. This elimination was attributed to hypolimnetic oxygen deficiency and extreme water level fluctuations.

Isom (1971), in his studies of the fresh water [illegible] of the Tennessee River, found the principal changes in the [illegible] caused by reservoirs on the Tennessee River were: (1) [illegible] by some species; (2) intrusion of species unreported prior to impoundment; and (3) reduction or elimination of native species. The [illegible] of the Tennessee River had been reduced from nearly 100 species to [illegible] species at the time of Ison's study. Isom concluded that mussel populations have been significantly affected by impoundments in species [illegible] and in distribution, due mainly to the loss of suitable [illegible] water habitat. [illegible] (1962) states that the pre-impoundment assemblage of [illegible] species in Kentucky Reservoir, Tennessee River, is doomed; only [illegible] has adapted to the altered ecological conditions. Isom [illegible] concludes that the recent decline in mussel populations is attributable to impoundment and over-harvest. Stansbery (1964) studied the mussels [illegible] Shoals, Tennessee River, and found that of the 63 species originally recorded, only 30 species remained below Wilson Dam. Stansbery [illegible] states [illegible] 95 percent of North American fresh water mussels are [illegible] obtain their food and oxygen from a current of water. [illegible] concluded that the survival of juvenile mussels was severely [illegible] Tennessee River due to environmental changes since the river [illegible].

Briggs (1948) demonstrated that the production of [illegible] was greater downstream of a reservoir on a small [illegible] of the reservoir. He concluded that the greater [illegible] was due to modification of highly fluctuating water [illegible]. Cushing (1963) found that filter feeding benthic [illegible] below reservoirs because of a richer supply of suspended food [illegible] discharging from the reservoirs. Isom (1971) concluded [illegible] benthic fauna below some impoundments on the [illegible] by seasonally low oxygen tension. Spence and Hynes [illegible] types of changes in the benthic fauna in the cold tailwater [illegible]. The three changes were: (1) reduction in total number of species, (2) increase in the numbers of some species; (3) replacement of other species by closely related ones. The physical reasons for these changes were concluded to be: (1) alteration of the temperature regime; (2) outflow of large amounts of organic matter; (3) alteration of the water flow fluctuations. McGary and Harp (1971) found a very limited benthic fauna in the cold tailwaters of a reservoir on the Little Red River, Arkansas. Another limiting factor below a reservoir can occur from changes in oxygen concentrations depending on the amount of water released from the oxygen containing epilimnion or anoxic hypolimnion.

b. Union Lake. Based on the [illegible] concluded that Union Lake will have a [illegible] populations of benthic invertebrates in the [illegible] characteristics of Union Lake will [illegible] Lake than those of the Tennessee River [illegible], concluded that Union Lake will [illegible] change in the dominant species within the [illegible] the reservoir will cause an increase in the [illegible] an increase in available bottom habitat. [illegible] not be a factor in limiting benthic invertebrate [illegible] the low turbidity levels in the [illegible] deficiency may be a limiting factor [illegible] may affect the standing crop of benthic [illegible]

Union Lake will [illegible] fauna in the reservoir area [illegible] that most of the species present [illegible] A few species that are [illegible] Quadrula quadrula, [illegible] fluctuations are not expected [illegible], some mussel populations [illegible]. Mussel populations [illegible] the 39 species of mussel [illegible] occidentales, has been [illegible] exten- sive collections [illegible] However, at this time, the [illegible] survival in the basin. This species [illegible].

c. Downstream of the dam. [illegible] have shown that the discharge from Union Lake [illegible] and the water quality of the discharge [illegible] to be sig- nificantly different than that of the [illegible] River at the present. Con- sequently, the benthic invertebrate [illegible] of the reservoir will prob- ably not be significantly affected by the water quality of the reservoir discharge. The modified flow regime, reducing flood and drought conditions, will probably benefit existing benthic populations. However, it is noted that the benthic populations which now exist in the Bourbeuse River are, in part, a product of natural fluctuations in the river regimen; and it is possible that modification to this regimen will, through the artificial provision of selective advantages, alter the species composition and/or population sizes which exist in the natural regime.

4.2.1.3 The Impact of the Project on Fish in the Inundated Area

a. General: The impoundment of a section of a stream [illegible] generally brings about a pronounced change in the fish population, [illegible] in the impounded section, but in the tributary streams above the [illegible] the stream below the dam. Whether this change is for the better, [illegible] matter of opinion which centers on the relative desirability [illegible] stream communities. This section will attempt to evaluate the [illegible]

fish population in the Bourbeuse River as it now exists and to analyze the impact of the proposed dam on this population. The reader is referred to paragraphs 2.2.3.4 and 2.2.5 for additional discussion of fish resources.

Hall (1955) summarized the opinions of several fisheries authorities concerning stream fishes in impoundments as follows: (1) the species which inhabit quiet-water areas of streams are usually present in the impoundments; (2) species which li[illegible] in fast-water habitats of streams usually disappears from the impoundments on those streams, some more rapidly than others; (3) stream species are often found in lakes around the mouths of tributaries, but his may be attributed to wandering from the typical habitat; (4) during winter and early spring, some "typical" stream species may be present in reservoirs for several years following impoundment; (5) under certain environmental conditions, such as lakes with clear water, little or no siltation of bottoms, and gravel and rock shorelines, some "typical" stream species may be retained indefinitely.

Knapp (1958) found considerable changes in the fish population of the White River as a result of temporary impoundment. A pre-impoundment check revealed 32 species, mainly shiners, darters, and suckers. Sampling after temporary impoundment yielded only 16 species. Centrarchids comprised the bulk of the post-impoundment population, along with brook silversides, bullheads, gizzard shad, and golden redhorse, in addition to a number of other species, many of which were virtually absent from the river before impoundment. Conversely, most of the shiners, darters, and suckers present before impoundment were drastically reduced or absent after impoundment.

Gasaway (1970) found that the total number of adult fish in Lake Francis Case, South Dakota, has declined since impoundment in 19[illegible]; however, there was considerable variation among species. He found that growth rates of many species followed the same general trend that has been recorded in impoundments throughout the country. Typically, initial rapid growth rates are followed by a longer period during which growth rates gradually decline before stabilizing, often at pre-impoundment levels. The increase in growth rates is accompanied by an often explosive increase in the number of individuals of certain species, particularly centrarchids and [illegible]. This is generally attributed to a great increase in habitat suitable to these species and the resultant increase in food supply. While the populations of some species were expanding rapidly, many other species, particularly shiners, darters, and suckers, declined or disappeared entirely (Gasaway, 1970; Knapp, 1958).

Patriarche and Campbell (1958) reported that smallmouth bass, rock bass, grass pickerel, hog sucker, and spotted sunfish were all unsuccessful in establishing populations in Clearwater Lake and noted that these species are virtually absent from other Missouri impoundments. They attributed this, at least in part, to a lack of suitable spawning habitat and poor survival of young. Probable reasons for poor population growths of other species in Clearwater Lake include small initial brood stock (walleye,

black buffalo, spotted sucker, northern carpsucker, gar, flathead catfish, and sauger) and competition with closely related species (black crappie, yellow bullhead, black redhorse, mooneye, and shorthead redhorse). Among the small fishes, four species, the brook silverside, bluntnose minnow, bigeye shiner, and whitetail shiner were most abundant. These species generally inhabit pools in the river habitat, and according to Hall (1955), would be expected to be fairly abundant in an impoundment. The presence of several other species of small fish (stoneroller, bigeye chub, hornyhead chub, bleeding shiner, popeye shiner, and wedgespot shiner) in the reservoir was attributed by Patriarche and Campbell (1958) to their movement from the river and tributaries into the lake.

The effect of stream impoundment on the fish populations of tributary streams was studied by Ruhr (1957). Among the objectives of the study was an attempt to determine the extent to which several species of "lake" fish (gizzard shad, carp, buffalo, and drum) inhabited smallmouth bass - rock bass streams in Tennessee. To do this, he compared the fish populations of the tributary streams of an impounded river (Duck River) with those of an unimpounded river (Cumberland River). Typical stream species made up 73 percent by weight of the fish in the Duck River watershed (impounded) compared to 97 percent in the Cumberland watershed (unimpounded). Although the "lake" species were more abundant in the Duck River watershed, there was little evidence to indicate that any of the four species had more than minimal spawning success in the tributaries. Their presence in the tributaries is probably the result of population pressure in the reservoir forcing them into the less crowded tributaries. Conversely, the tributaries of the unimpounded Cumberland River yielded few "lake" fish.

b. Union Lake: The ichthyofauna of the Bourbeuse River is dominated by four families of fishes: the cyprinids (minnows) with 28 species; the catostomids (suckers) and percids (perches) each with 12 species; and the centrarchids (sunfishes) with nine species. Thirteen other families containing 22 species bring the total number of species to 83.

Impoundment of a section of the Bourbeuse River will substantially reduce the diversity of the fish fauna in the area of impoundment. Because of habitat requirements, competition, and other reasons, approximately 48 species, 56.5 percent of the species now inhabiting the river, will be reduced in number or completely eliminated from the impounded area. The status of another 12 species (15.7 percent) is undetermined. Twenty-three species (27.7 percent) now present are expected to increase in number when the stream is impounded. A more detailed discussion of the impact of impoundment on the more common species is presented below.

c. Species Decreased or Eliminated by the Reservoir: As noted in Table 4, 48 species representing eight families, will decrease or be eliminated by the proposed reservoir. Of the 48 species that are expected to be most adversely affected, 23 are cyprinids (minnows), nine are percids (perches), and nine are catostomids (suckers). Several species that comprise a substantial part of the sport catch, including the rock bass and

several species of suckers, are expected to be sharply reduced in number in the impounded area. A brief discussion of the more important species that may be adversely affected is presented below and listed in Table 4.

Table 4 - Species that will probably be eliminated or reduced in Union Lake

American eel	Creek chubsucker
Stoneroller	White sucker
Silverjaw minnow	Northern hog sucker
Bigeye chub	Spotted sucker
Gravel chub	Silver redhorse
Hornyhead chub	River redhorse
Pallid shiner	Black redhorse
Bigeye shiner	Golden redhorse
Striped shiner	Shorthead redhorse
Bigmouth shiner	Slender madtom
Wedgespot shiner	Stonecat
Rosyface shiner	Northern studfish
Spotfin shiner	Rock bass
Sand shiner	Greenside darter
Redfin shiner	Rainbow darter
Mimic shiner	Fantail darter
Steelcolor shiner	Johnny darter
Bleeding shiner	Orangethroat darter
Suckermouth minnow	Missouri saddled darter
Southern redbelly dace	Banded darter
Bluntnose minnow	Gilt darter
Fathead minnow	Slenderhead darter
Bullhead minnow	Mottled sculpin
Creek chub	Banded sculpin

(1) Suckers: A number of suckers, including the white and blue suckers, and the silver, river, golden, black, and shorthead redhorses, will probably be reduced in number or completely eliminated from the impounded area. This is primarily a result of the change to a lacustrine habitat from the generally clear, flowing water preferred by these species. They will probably remain in sections of those streams above the reservoir that are not a part of the flood pool.

(2) Rock bass: The rock bass is one of the most frequently caught game species in the Bourbeuse River. In this area, it is primarily a stream species and will probably decline in the impounded area because of the change in habitat and increased competition from those predatory species such as the largemouth bass that thrive in impoundments. Its abundance in the streams above the normal pool will depend on a number of factors, including competition from other predators and the degree of habitation of those streams by rough species such as carp, drum, shad, and buffalo. Ruhr (1957) reported a decline in the quality and quantity of smallmouth bass and

rock bass fishing in streams during the time they were inhabited by carp, and he recommended protecting smallmouth - rock bass streams from these rough species.

d. Species Increased by the Reservoir: The decline of many species in the impounded area will be accompanied by an increase in many others. At least 23 species representing 12 families are in the latter group (Table 5). Included are six species of centrarchids (sunfishes) and four ictalurids (catfishes), plus the carp, drum, gizzard shad, and others.

Table 5 - Species that should increase in Union Lake

Chestnut lamprey	Gambusia
Longnose gar	Brook silverside
Gizzard shad	Orangespotted sunfish
Grass pickerel	Bluegill
Carp	Longear sunfish
Quillback	Largemouth bass
Highfin carpsucker	White crappie
Black bullhead	Log perch
Yellow bullhead	Walleye
Channel catfish	Freshwater drum
Flathead catfish	

A brief discussion of the more important species follows:

(1) Gar: Both the shortnose and longnose gars occur in the Meramec Basin. Only the longnose gar, however, has been reported from the Bourbeuse River. It is generally the only gar in the clear, high-gradient streams of the Ozarks and reaches its greatest abundance in large reservoirs of that region (Pflieger, 1971). It is expected to thrive in Union Lake.

(2) Gizzard shad: The gizzard shad is only a minor species in the Bourbeuse River. It occurs in a variety of habitat types, generally avoiding only streams with extremely high gradients or those lacking large, permanent pools. It thrives in large impoundments and often comprises a substantial part of the standing crop. In these waters, it is often an important item in the diet of many of the predator species, including bass, gar, and white bass. The gizzard shad is expected to comprise a substantial portion of the lake's standing crop.

(3) Carp: The carp is one of the most abundant fishes in Missouri. It prefers a wide variety of habitat types, from clear, flowing streams to backwater areas of rivers to impoundments. It is expected to make up a substantial part of the fish fauna of the impounded area, and will probably move up into the tributary streams above the dam as their numbers increase in the impoundment.

(4) Suckers: Suckers comprised the bulk of the standing crop in Huzzah and Courtois Creek (Fajen, 1972), as they do in many Ozark streams, although they were only five percent of the catch in those creeks. While suckers were also expected to be an important part of the fish fauna in Union Lake, the species, which are collectively known as suckers, will be

quite different [illegible] "[illegible]" [illegible] in the sport [illegible] are primarily the [illegible], [illegible] flowing waters [illegible] stream habitat. [illegible] "[illegible]" [illegible] the impoundment generally prefer quiet waters [illegible] carp, sucker, [illegible], and [illegible] Meramec River, [illegible] species [illegible] to do well in the tributaries above the dam, but [illegible] populations of the other species of "[illegible]" increase in the impounded area, these species will probably [illegible] as well.

[illegible] catfish [illegible] Arkansas River [illegible] and yellow bullhead, [illegible] catfish, and the flathead [illegible]. These species [illegible] percent of the sport [illegible] in the Meramec Basin. [illegible], the channel catfish will probably do best in the impoundment. Patriarche and Campbell (1958) found that it took five years for channel catfish to produce a successful year class in Clearwater Lake, but predicted that they would continue to be an important part of the fishery. [illegible] reported channel catfish to be 7 percent of the catch in [illegible] Reservoir, [illegible] flathead [illegible] increase in the impoundment, and although individuals attain large size, they will be a minor part of the [illegible] population. [illegible] generally show an increase in number after impoundment, with [illegible] (1970) report [illegible] Lewis and Clark Lake, South Dakota, since the early [illegible] of impoundment. Patriarche and Campbell (1958) reported a decline [illegible] in Clearwater Lake, but a fairly stable population [illegible] bullheads in that lake.

[illegible]. As a group, sunfishes, excluding [illegible], are the number one sport fish in the Meramec Basin. [illegible] Included under the heading "sunfish" are the green sunfish, [illegible], redear, [illegible] spotted sunfish, and [illegible] perch [illegible]. These species are all expected to increase their populations, [illegible] degrees, in the impounded area.

The bluegill and longear sunfish will probably show the greatest increase. Patriarche and Campbell (1958) reported that these two species became extremely abundant in Clearwater Lake, Missouri, soon after impoundment. Bluegill comprised [illegible] percent of the [illegible] in Pickwick Reservoir (TVA, 1966) and green sunfish, 1.6 percent. The longear sunfish is the most abundant inhabitant of the littoral zone of Bull Shoals (Applegate, et al., 1966). The same general results have been reported by many other authors.

If impounded, the white and black crappie will increase, although the white crappie probably will be the more abundant of the two. Both species are currently insignificant in the sport catch of the Meramec Basin, but since they comprise the largest part of the catch in some other impoundments (Patriarche and Campbell, 1958; Gasaway, 1967; Gasaway, 1970), they may be quite important in this reservoir. In this regard, Knapp (1958) reported a marked increase in crappie in Table Rock Lake after impoundment.

Growth rates of sunfishes are generally rapid for the first few years after impoundment, followed by a period during which growth rate decline. This is attributed to an increase in good habitat and available food in the newly impounded area followed by a period of general decline as the system begins to stabilize.

([illegible]) <u>Black basses</u>: Three species of black bass, the smallmouth, largemouth, and spotted bass, occur in southern Missouri. The largemouth and smallmouth bass have been recorded from the Meramec Basin. Although not reported from the Meramec Basin, the spotted bass occurs in streams of adjoining basins, and could become an important element of the fish population if introduced into the impounded area.

In Missouri, the largemouth bass generally prefers warmer, quieter waters while the smallmouth generally occurs in cool, clear streams and parts of some lakes. The habitat requirements of the spotted bass are somewhat intermediate between the other two species. Trautman (1932) reported that both largemouth and smallmouth bass had been stocked in streams of southern Ohio for 40 years, yet the spotted bass, which had never been stocked, was the dominant fish in these lowland streams.

The smallmouth bass is the most abundant black bass in the Meramec Basin. It is a significant part of both the standing crop and sport catch. The largemouth comprises a very small part of the sport catch and the standing crop. The relative abundance of these two species is generally reversed in impoundments. The population of all black basses expand rapidly during the first few years following impoundment. However, the initial expansion of the smallmouth population is usually followed by a sharp decline, often to the point that few or none are taken by anglers after the first two or three years. For reasons as yet undetermined, smallmouth bass have begun to reappear in the sport catch of several reservoirs (Jenkins, pers. com., 1972) after being absent for a period of about 10 years. According to the Gillham Environmental Impact Statement (U. S. Army, Corps of Engineers, Tulsa District, 1972), standing crops of smallmouth bass have been recorded from 42 reservoirs, many of which have been impounded for over 20 years. These are listed in Table 6.

Table [illegible] - Reservoirs in which standing crops of smallmouth bass have been recorded. The year of impoundment is in parenthesis.

Apalachia, N. C. (1943)	Hiwassee, N. C. (1940)
Barren, Ky. (1964)	James, N. C. (1919)
Beaver, Ark. (1964)	Kentucky, Ky. (1944)
Blue Ridge, Ga. (1931)	Lake O'the Cherokees, Okla. (1940)
Boone, Tenn. (1952)	Nantahala, N. C. (1942)
Buckhorn, Ky. (1961)	Nolin, Ky. (1962)
Bull Shoals, Ark. (1951)	Norfork, Ark. (1943)
Center Hill, Tenn. (1949)	Norris, Tenn. (1936)
Chatuge	Ouachita, Ark. (1952)
Cherokee, Tenn. (1942)	Pickwick, Tenn. (1938)
Chickamauga, Tenn. (1940)	Quabbin, Me. (1939)
Cumberland, Ky. (1950)	Santeetlah, N. C. (1928)
Dale Hollow, Tenn. (1943)	W. Kerr Scott
Deep Creek, Md. (1924)	South Holston, Tenn. (1951)
Eucha, Okla. (1952)	Sutton, W. Va. (1960)
Fontana, N. C. (1944)	Tenkiller, Okla. (1953)
Ft. Loudon, Tenn. (1943)	Watauga, Tenn. (1949)
Ft. Patrick Henry, Tenn. (1954)	Watts Bar, Tenn. (1942)
Glenville, N. C. (1941)	Wheeler, Ala. (1937)
Guntersville, Ala. (1939)	Wilson, Ala. (1924)
Herriggton, Ky. (1925)	Woods, Tenn. (1952)

Largemouth bass populations exhibit a similar expansion and decline; however, the decline is not nearly as severe as that of the smallmouth. When the fish population in the reservoir begins to stabilize, the largemouth is generally one of the most abundant predators, along with crappie, and possibly, white bass. The spotted bass, when present, generally reaches a level of abundance somewhere between the other two species of black basses, the largemouth and smallmouth basses.

Smallmouth bass commence spawning at water temperatures of about 62°F; spotted bass begin at about 64°F; and largemouth bass at about 66°F (Bennett, 1962). Where the three occur together, this can mean as little as two days to as much as two weeks difference between the spawning of smallmouth and largemouth bass, with the spotted bass somewhere between the other two species.

The success of a year-class of largemouth bass is influenced by a number of factors, including weather, physical, chemical, and biological conditions of the habitat, size and fecundity of the spawning stock, food and predation (Kramer and Smith, 1962). No relationship was found between the number of spawners and the size of a year-class produced (Bennett, 1954).

Hodson and Strawn (1968) reported quite similar food habits for fingerling spotted and largemouth bass during the filling Beaver Reservoir, Arkansas Spotted bass grew more slowly, but were in better condition at the

end of the growing season. In comparing food habits of largemouth bass in a new reservoir (Beaver) with those in an old reservoir (Bull Shoals), Applegate and Mullan (1967) found that fish appeared in the diet of bass from Beaver at an earlier age and that this resulted in substantially faster growth. This was attributed to the presence in the new reservoir of larger food items, particularly cladocera and midge larvae which "bridges the gap" from an entomostracan diet to a fish diet. These large items were almost entirely lacking in bass from the older reservoir.

Mullan and Applegate (1967) found that the food habits of the three species of black basses in the same size group were essentially the same. However, large smallmouth bass are somewhat less piscivorous. In addition to strong intraspecific competition, Burress (1962) and Hanson (1967) reported strong competition between the black basses and crappie and white bass.

Once the fish population in the impounded area begins to stabilize, the largemouth bass will be the dominant black bass. The success of the smallmouth will depend on several factors, including available spawning habitat. Smallmouth should continue to spawn in the tributary streams and possibly in the lake. Whether the smallmouth can produce enough offspring in the streams to maintain a significant population in the lake is uncertain. Webster (1954) found that smallmouth bass in Cayuga Lake, New York, spawned in the tributaries and dispersed throughout the lake, traveling as much as [illegible].5 miles. He also reported some spawning in the lake. Another factor affecting the abundance of smallmouth will be the presence of spotted bass. If the spotted bass is present, it will offer competition for both the largemouth and smallmouth. If the spotted bass invades the tributaries, the pressure on the smallmouth bass will be that much greater.

The three black basses can exist in the same body of water. In Tenkiller Ferry Reservoir, Oklahoma, impounded in 1952, largemouth bass comprised 4.4 percent of the catch, while smallmouth and spotted bass were each 1.3 percent of the catch (Gasaway, 1967). In Pickwick Reservoir, Alabama, largemouth bass were 2.2 percent of the standing crop, smallmouth bass, 1.1 percent, and spotted bass, 0.1 percent. The future status of the smallmouth bass in Union Lake is quite uncertain at this time.

Another factor that will influence the smallmouth bass population is the expected influx of "lake" species (i.e., carp, drum, buffalo) into tributary streams caused by the buildup of large populations of these species in the reservoir. Where these species have unlimited access to the tributaries, a decrease in the numbers of stream species was observed (Ruhr, 1967). Mill dams and waterfalls on small streams were found to be effective barriers to upstream movement of "lake" fish. Where these obstructions were present, "lake" fish were generally rare or absent and native stream species, including smallmouth and rock bass, were more abundant. On unobstructed streams, no marked relationship was detected between abundance of lake fish and the distance from the reservoir. Also, no correlation was found between fish populations in reservoirs and those of their tributaries.

(8) Walleye: The walleye is a very minor element of the fish fauna throughout the Meramec Basin. However, it reaches its greatest abundance in the large streams and reservoirs of the Ozarks and is expected to increase its numbers in the Union Lake.

(9) Freshwater drum: The drum is another species that is uncommon in the Bourbeuse River, but because of its abundance in reservoirs throughout its range and its preference for quiet waters, it is expected to significantly increase after impoundment.

e. Species of Uncertain Status: The status in the reservoir of 12 species representing seven families that are currently found in the river is uncertain. Included in this group are the rainbow trout, smallmouth bass, and sauger, plus several minor species (Table 7).

Table 7 - Species of uncertain status in Union Lake

Least brook lamprey	Emerald shiner
Goldeye	Red shiner
Mooneye	Blackstripe topminnow
Silver chub	Green sunfish
Golden shiner	Smallmouth bass
	Sauger

Of the species whose status is uncertain, the smallmouth bass is by far the most important in the Bourbeuse River. It is discussed in the previous section under black basses. The rainbow trout is only occasionally taken from the Bourbeuse River; and its presence in the Meramec Basin is the result of a stocking program by the State of Missouri. Most of the prime trout habitat in the basin will be eliminated by the construction of Meramec Park Lake. If the stocking program is discontinued, the rainbow trout would soon disappear from the sport catch.

f. Estimated Fish Standing Crop and Angler Harvest: Jenkins (unpub. 1972) lists a number of multiple-regression formulas which can be used to estimate fish standing crop and angler harvest, provided certain environmental variables are known. The pertinent environmental variables for Union Lake are listed in Table 8. Using Jenkin's formulas, a number of predictions can be made about the standing crop of fishes in the proposed Union Lake. (See Table 10)

Table 8 - Environmental variables for Union Lake

Variable	Union Lake
Area (acres)	7100
Mean depth (ft.)	29.0
Outlet depth (ft.)	10
Storage ratio	0.47
Shore development	8.5
Dissolved solids (ppm)	140
Growing Season (days)	180
Thermocline depth (ft.)	25

The predicted harvest values for Union Lake are presented in Table 10.

Table 10. Predicted harvest values for Union Lake.

Reservoir Age (yrs)	Black Bass (lbs/acre) (Formula E_1)	Sunfish (lbs/acre) (Formula F_1)	Sport Fish (lbs/acre) (Formula H)	Sport Fish (Fish/acre) (Formula K)	Sport Fish (lbs/hour) (Formula M)
1	8.6	12.7	52.9	123.0	0.67
2	6.8	8.3	42.8	94.8	0.61
5	5.0	4.7	32.3	67.1	0.54
10	4.0	3.1	26.2	51.7	0.50
20	3.2	2.0	21.2	39.9	0.45
50	2.3	1.1	16.0	28.2	0.40
100	1.9	0.7	12.9	21.8	0.37
100 year mean	2.8	1.9	18.8	34.9	0.43

No standing crop data are available for the Bourbeuse River; therefore, no comparison can be made between the predicted standing crop values for Union Lake (Table 11) and the existing situation in the Bourbeuse River.

Table 11 - Estimated standing crop values for Union Lake (per acre)

	Value (lbs per acre)
Standing Crop - clupeids	70.2
Standing Crop - black bass	12.7
Standing Crop (less clupeids)	108.0
Total standing crop	190.9

The estimated standing crop and sport fish harvest values do not include the tailwater below the proposed dam. These areas generally receive heavy fishing pressure, often exceeding that of the reservoir itself on a per-acre basis. A discussion of the tailwater fishery is included in the following section.

4.2.1.4 Impact on the Project on Fish Below the Dam

Maintenance of the warm water fishery in the Bourbeuse River below the dam is a prime objective of the Missouri Department of Conservation. To meet this objective, the Corps of Engineers has incorporated several features into its plans for the dam that are designed specifically to maintain the fishery below the dam. In accordance with requests from the Missouri Department of Conservation and the Bureau of Sport Fisheries and Wildlife, the Corps of Engineers will construct a multi-level weir to control the flow of water through the outlet structure. Maximum flow through the outlet will be 4,000 c.f.s. and the minimum flow will be 11 c.f.s.

Flow through the outlet structure will be controlled by an adjustable gate in the structure. The elevation of the normal pool will be 619 feet m.s.l., and the top of the weir will be at elevation 599 feet m.s.l. Removal stoplogs, each 36 inches in height, will permit water to be drawn from lower elevations, if necessary. The construction of the top of the weir at elevation 599 feet m.s.l., will ensure that the water to be discharged downstream will be drawn from the warm epilimnionic layer, rather than from the colder hypolimnion, as is sometime the case in other reservoirs.

The result of this will be that water temperatures downstream from the dam will be quite similar to those of the undammed river, thus maintaining the integrity of the downstream fauna. Dissolved oxygen in the river below the dam should also be sufficiently high to support the downstream fauna. In addition to being drawn from the oxygen-rich epilimnion, a series of seven baffle piers in the stilling basin, designed to reduce the velocity of the outflowing water, will create an area of turbulence and increase the oxygen content of the water at that point.

The maintenance of a minimum and maximum flow of water below the dam should be a stabilizing factor on the fish population by eliminating the extreme water conditions such as flooding and droughts that are often destructive to the fish populations.

Tailwaters often contain quite a large and diverse fish population. The stilling basin below Canton Reservoir, Oklahoma, has a fish standing crop of 5,590 pounds per acre in 1969 compared to 525 pounds per acre in 1969 in the reservoir (Moser and Hicks, 1970). Game fish were 35.9 percent of the standing crop in the stilling basin below Canton Reservoir. Hall and Latta (1952) reported that game fishes comprised 73.5 percent of the total number of fishes and 45.5 percent of the total weight of fishes in the stilling basin below Wister Dam, Oklahoma. Bacon, et al., (1968) reported that centrarchids increased in abundance in the cold tailwaters of Bull Shoals Reservoir since impoundment. They also reported that white bass and walleye appeared periodically during the spawning season.

Tailwater areas are often the site of the most intense fishing pressure associated with a reservoir. Fry (1962) reported that the fishing pressure on the tailwaters of Table Rock, Taneycomo, and Clearwater Reservoirs was 7, 10, and 16 times greater on a per acre basis than in the respective reservoirs, and that 10 percent of all fishing trips were on the tailwaters. In each case though, the catch rate was lower than on the reservoir. In many reservoirs, however, the catch rate in the tailwaters exceeds that of the impoundment (Pfitzer, 1967).

Fluctuation of the water levels in a stream because of flooding or drought often affects the amount of fishing pressure on the stream. Wood and Whelan (1962) studied the Chattooga River in Georgia, a stream with a relatively steep gradient and little flood plain, as part of a study on low flow regulation as a means of improving stream fishing. They concluded that high water stages were of too short duration to be of much value in fish production and that flash floods sometimes damage the habitat by scouring and by excessive sand and gravel deposition in deep holes and shoal areas. Excessively low stages, in turn, reduce the acreage of productive waters and discourage use by fishermen. The study revealed that present, as well as potential utilization, is curtailed by excessively low stages and sometimes by excessively high stages during the fishing season. Fishery benefits from low flow regulation accrue in the form of increased carrying capacity of the stream habitat, an increase in percent by weight of game fish in the population, and an increase in the number of days per year that the stream will be fishable.

The tailwaters below the Union Lake are expected to receive heavy fishing pressure. Most of the sport fish now present in the river should be present in the tailwater. As the fishing pressure increases in the tailwater area and harvest increases, a decrease in the average size of harvestable fish may occur. The effect of more stable water levels below the dam should be beneficial to fish populations in that area and should result in increased fishing opportunities.

4.2.1.5 Fish Hatchery

The Missouri Department of Conservation has expressed an interest in the feasibility of constructing a fish hatchery immediately downstream of the dam. If constructed, two 18-inch diameter steel-lined conduits with intakes at elevations 609 m.s.l. and 584 m.s.l. would be provided for water supply to the hatchery.

4.2.1.6 Flood Pool

High water during spawning periods is expected to be beneficial because of the increase in shallow water area used for spawning.

4.2.2 IMPACTS ON TERRESTRIAL ORGANISMS

4.2.2.1 The Impact on Terrestrial Organisms in the Reservoir Area

a. General: The project will have an immediate impact on plant and animal populations in the areas of impoundment. Plants, relatively immobile animals, and species confined by severe habitat requirements, will be killed. Most mobile species are expected to leave the project area, either during reservoir clearing, or as water rises during impoundment. Those individuals will be forced to compete for limited or presently occupied habitat beyond the impounded area. Temporary increases in some animal populations, as a result of immigrations, are expected, but these increases will be virtually insignificant within a few seasons. Some deterioration of existing habitat may occur as a result of temporary overstocking, but this too will probably be insignificant within a few seasons.

Filling of the flood pool, especially during the spring, would have an adverse effect on ground-nesting and burrow-nesting wildlife species that would be using the flood pool area for breeding.

The inundated area, because of its fertile, alluvial soils and because of its interspersion of forest and agriculture, provides highly desirable and diverse habitat types. These areas are similar in productivity to most of the undeveloped or semi-developed flood plains in the basin, but demonstrably more productive than most upland areas in the basin. The present terrestrial environment is viewed as a renewable resource, and as such, has the ability to replenish itself indefinitely. The significant impact from inundation will result from the reduction in carrying capacity for the whole project area, since the bottomlands are the key area for the productivity of many wildlife species.

b. Vegetation: Construction of this project will result in both direct and indirect impacts on vegetation located within the limits of the project area and also upon that of the surrounding region. Direct impacts can be rather easily ascertained and described, while indirect impacts are less readily defined and described.

The most significant direct impact will be that which will result in the total removal of vegetation on land cleared for reservoir construction and inundated by the reservoir. About 6,600 acres will be affected in this manner, of which about 65 percent are forested. The most productive sites on the project will be permanently lost from production and changed into aquatic habitats.

A clearing policy will be determined in coordination with the appropriate Federal and state agencies, and will be based on such considerations as recreation, fish and wildlife, boating safety, and public health.

Since development of the project will involve fee-purchase of 21,993 acres, there will be about 15,393 acres of land which will lie around the perimeter of the reservoir at normal pool level. Some of this land will remain undeveloped for the immediate future while a portion of it will be developed. The vegetation on the developed areas will be either removed or altered to some degree. Undeveloped lands will be retained in their present plant cover or will be improved through application of management practices.

Because one purpose of the project is flood control, about 1,494 acres will be subject to inundation about every two years, while an additional 735 acres will be subject to inundation about every five years. These periods of inundation will exert some influence on the species composition of the plant communities. The effect will vary with the length of time and degree of inundation. It is anticipated that there will be some change in species composition, growth rates, and quality of vegetation as the environmental conditions of sites peripheral to the reservoir are changed. These sites may be expected to support mesic plant communities, or at least a higher proportion of mesic species.

Flooding easements will be acquired on about 1,892 acres of land which lie above the fee-owned project lands. Because of the type of use restrictions imposed on these lands, the land use is not expected to change significantly; and the effects of the project on the vegetation located on these lands will be relatively minor.

The most difficult impacts on vegetation to assess are those which will occur indirectly as a result of the project development. These impacts will occur on private lands surrounding the project as a result of changes in land use which are generated by the existence of the project. It is also difficult to estimate the extent to which changes on these lands can be attributed primarily to project development, since it is very probable that a portion of these changes will occur even without development of the project. There has been a trend toward changed land use in the project area because of its proximity to the St. Louis metropolitan area. Some industrialization has occurred; local communities are expanding into the surrounding rural areas; and rural acreage is being developed for homesites. This trend may be expected to continue and to increase in magnitude; however, development of the project may be expected to accelerate the trend.

Two impacts appear most likely. The first will be a reduction in the use of resources as the new owners will probably desire to "preserve" their lands for their recreational value. This desire for "preservation" may result in the withdrawal of some acreage of forest land from production of commercial forest products. However, if these new owners seek professional advice in the management of their lands, the opportunity will be presented to show them the values of multiple-use management, which would have a definite valuable effect. The other impact, the opposite of "preservation", is expected to be that caused by land development, including subdivisions, campgrounds, and various types of commercial enterprises which will be attracted by the lake. The impact of these "developments" on the vegetation may be positive or negative, depending upon zoning, management, and similar influences. However, such developments have historically greatly reduced the extent of natural vegetation.

c. Animals: The reader is referred to paragraph 2.2.1.5 for a further discussion of animals in the Meramec Basin.

(1) Invertebrates: All terrestrial invertebrates will be lost from the inundation area. This will include those species characteristic of spring and cave communities. Changes in aquatic invertebrate populations has been discussed in paragraph 2.2.3.3.

(2) Vertebrates:

(a) Amphibians: This group of animals is confined to moist or aquatic habitats during at least part of their life cycle. All of the species that occur in the project area are expected to continue existence in that area, except for the hellbender which will probably be extirpated from the inundated area. Live hellbenders bring from $15 to $35 commercially and may achieve a population density of up to one per 8-10 square meters of river. In most cases, prime habitat for these species includes moist woodlands near standing or running water. After impoundment, these species will generally be confined to the lake periphery and its tributaries; consequently, there will be a reduction in abundance, but not in diversity (except for the hellbender). Certain species are expected to increase in numbers because the reservoir shoreline and the increase in shallow, still water will improve their habitat. This includes the central newt, the western chorus frog, the southern leopard frog, the bullfrog, the green frog, and the bronze frog.

(b) Reptiles: Twelve species of turtles are known from the basin. Nine of these turtles are semi-aquatic in habitat, and most will easily adapt to the lake habitat, and probably become more abundant than they presently are. The alligator snapping turtle, although present in the basin, probably does not occur in the project area and, consequently, will not be affected. Two terrestrial turtles, the ornate and the three-toed box turtles, will be eliminated from the impounded area, but will remain common on upland areas around the lake.

All of the species of lizards known from the basin probably occur in the area of inundation, and all will be reduced in number by inundation. However, all species will remain in the project area.

Twenty-six species of snakes occur in the project area. Approximately 10 of these are characteristic of dry upland habitats and should not be appreciably affected by the lake. Six species are characteristic of moist woods and these may be substantially reduced in number, but will still occur around the lake. Three species are water snakes and are expected to increase in number after impoundment.

(c) Birds: Approximately 288 species of birds are known from the Meramec Basin, and it is reasonable to assume that all but the rarest species utilize some portion of the area to be inundated. Of primary significance is whether or not the inundated area provides sufficiently important habitat to adversely affect bird populations in the remaining (not inundated) area. Table 12 lists 61 species of birds that are likely to be reduced in abun-

dance as a direct result of loss of important habitat. All but one species, the winter wren, breeds in this area. As indicated in Table 13 approximately 29 species are expected to be benefitted by the habitat provided by the lake. Two of these species, the pied-billed grebe and mallard, are uncommon breeders in Missouri, while the other 27 species are migrants. It is recognized that the reservoir will provide little breeding habitat for these species listed in Table 13 due to the fluctuating nature of the lake, there will be limited food production.

(d) Mammals: Most of the 53 species of mammals that occur in the project area are expected to be affected by the impoundment. The most significant impact will occur to those species which prefer moist bottomlands such as the shrews and species primarily adapted to stream environments such as the beaver and river otter.

4.2.2.2 Impact on Terrestrial Organisms Downstream of the Reservoir

a. General: The project will provide a high degree of protection to 7,020 acres of bottomland between the damsite and the mouth of the Bourbeuse River. An additional 21,920 acres of land between the mouth of the Bourbeuse and the Mississippi Rivers will receive partial protection.

Much of the land along the Bourbeuse River below the damsite is currently in forest, low intensity agriculture, high intensity agriculture, or low intensity residential and commercial land use. Intensified land utilization is expected with the advent of flood control, and three basic types of land use conversions are expected: (1) low intensity residential and commercial to higher intensity residential and commercial; (2) high intensity agriculture to low density residential and commercial; and (3) low intensity agriculture and forest to high intensity agriculture and low density residential and commercial.

Of these conversions, only the third is considered to have significant impact on plant and animal communities, and this impact is discussed below.

b. Low Intensity Agriculture and Forest to High Intensity Agriculture, Low Intensity Residential or Commercial Use: In the conversion of interspersed farm and forest land to very intensively farmed areas, or areas of residential or commercial development, most of the species characteristics of the forest - brushland - small farmland habitat will become uncommon, and will be largely replaced by species that can successfully compete in open or semi-urban situations, such as raccoons, opossums, rock doves (pigeons), mourning doves, crows, common night-hawks, barn swallows, meadowlarks, starlings, house sparrows, and grackles. It is noted that these species may also be less abundant than previously, but they will be relatively more abundant than other species. It is the conversion from small farm to intensive agriculture and other more intensive land uses that will have the greatest impact on game species. White-tailed deer, cottontail rabbit, gray and fox squirrels, turkey, woodcock, and bobwhite would all suffer substantial reductions in population. Furbearers such as mink, beaver, muskrat, and raccoon will also be less common.

Table 1[illegible]. Birds for which habitat will [illegible] reduced [illegible]

Great Blue Heron	Winter [illegible]
Wood Duck	Carolina [illegible]
Turkey Vulture	Catbird
Red-shouldered Hawk	[illegible]
Red-tailed Hawk	[illegible]
Bobwhite Quail	[illegible]
Turkey	[illegible]
Killdeer	[illegible]
Spotted Sandpiper	[illegible]
Mourning Dove	[illegible]
Yellow-billed Cuckoo	[illegible]
Screech Owl	Prothonotary [illegible]
Barred Owl	Worm-eating [illegible]
Chuck-will's-widow	Parula [illegible]
Whip-poor-will	Yellow [illegible]
Yellow-shafted Flicker	Cerulean [illegible]
Pileated Woodpecker	[illegible]
Red-bellied Woodpecker	Ovenbird
Hairy Woodpecker	Louisiana [illegible]
Downy Woodpecker	Kentucky [illegible]
Great Crested Flycatcher	Yellowthroat
Acadian Flycatcher	[illegible]
Eastern Phoebe	[illegible]
Eastern Wood Pewee	[illegible]
Barn Swallow	[illegible]
Blue Jay	[illegible]
Common Crow	[illegible]
Carolina Chickadee	[illegible]
Tufted Titmouse	[illegible]
White-breasted Nuthatch	[illegible]
Brown Creeper	[illegible]
House Wren	

Reference: Anderson (1972); Jackson (1972).

Table 1[illegible]. Birds for which habitat will be in[illegible]

Horned Grebe	[illegible]
Pied-billed Grebe	[illegible]
Double-crested Cormorant	Ruddy [illegible]
Whistling Swan	[illegible]
Canada Goose	[illegible]
Mallard	[illegible]
Black Duck	[illegible]
Gadwall	[illegible]
Pintail	[illegible]
Green-winged Teal	Bonaparte's [illegible]
American Widgeon	Forster's [illegible]
Redhead	[illegible]
Ring-necked Duck	Caspian [illegible]
Canvasback	Black Tern
Lesser Scaup	

Reference: Anderson (1972).

4.2.2.3. Impact on Terrestrial Organisms Elsewhere in the Basin

This section excludes consideration of the inundated area and the flood plain downstream of the reservoir. As noted in paragraph 2.3.2, the Meramec Basin will continue to develop, with or without the project; however, development will probably be accentuated by the project. It is impossible to make a quantitative distinction that would accurately demonstrate differences between impacts on terrestrial organisms between developments with and without the project. Consequently, this discussion will concentrate on the impact of development, per se, in the basin.

Further development in the unprotected flood plain will probably be largely confined to scattered recreational cottages and campgrounds. From a terrestrial-biological standpoint, these developments have a limited adverse impact. Some habitat is lost and some is created through increases in forest openings. Use is seasonal and generally does not involve large concentrations of people. On the whole, it appears that development in the unprotected flood plain will not be sufficiently intensive to seriously affect the biological resource.

Upland development will be more extensive. Although the upland areas are less productive biologically than the bottomland areas, they do provide important and often undisturbed habitat for many species. Substantial reductions of biological resources can be expected in areas of intensive residential, commercial, or industrial development. The impact will be progressively less in lower use areas. Approximately eight percent of the Meramec Basin is currently urbanized (Ryckman, et al., 1973). As the basin develops, increasing amounts of semi-developed and undeveloped land will be converted to urban usages. However, it is reasonable to assume that the basin will, for the foreseeable future, continue to contain large areas of undeveloped lands.

4.2.3 THE IMPACT OF THE RESERVOIR ON GAME SPECIES

This section is confined to the consideration of the impacts of inundation on game species. A general discussion of the impact of the project on game species in bottomland areas downstream of the dam and in the basin is included in paragraph 2.2.6.

As discussed in paragraph 2.2.6, prime habitat for most wildlife species in the Meramec Basin includes a mixture of hardwood forest and cropland. Although many of the game species known from the basin may be found throughout the area, the most important habitat occurs on the fertile soils of the bottomland area. The game animals, including [illegible] that will be affected by the project, are shown in Table 14. Although the impact on each species is in direct relation to the abundance of the [illegible] area, none of the wildlife species listed will benefit [illegible]. It should be noted that the significant loss is not a lo[illegible], but rather the loss of the continued productivity of the [illegible].

Approximately 22,000 acres of land that is [illegible] ownership will be more readily available for publi[illegible]. [illegible] includes the lake area and about 5,840 acres designate[illegible] uses such as camping and picnicking. Privately-own[illegible] Basin is currently used for hunting. Although thi[illegible] public, the limited access may have a beneficial effe[illegible] by helping to prevent over-harvesting. Additionally, [illegible] of land in the project area has a beneficial effect [illegible] providing an interspersion of habitat types and [illegible] food. When the Union Lake is in operation, a de[illegible] plan will be implemented by the Corps of Enginee[illegible]. [illegible] wildlife habitat in the uplands, but it cannot be [illegible] of the more productive agricultural bottomlands.

4.2.3.1 Impact on Game Mammals

a. White-Tailed Deer: The most important [illegible] in the project area will be the loss of the small agricultural units that are currently used to supplement their natural food supply. In addition, the natural food supplies that occur in the bottomlands are more abundant per unit area and of a higher nutritional level than that which occurs in the uplands.

b. Fox and Gray Squirrels: The loss of the bottomlands with their small agricultural units will greatly reduce fox squirrel populations in the project area since they make extensive use of farm crops. Gray squirrels will not be affected as much as fox squirrels, but they will also be reduced since the bottomlands have the majority of mature to over-mature trees that provide nesting cavities and are the most productive mast bearing trees.

Table 14 - Game and furbearers in the area of inundation.

Species	Estimated Current Population[1]	Species	Estimated Current Population[1]
White-tailed Deer	Moderate	Striped Skunk	High
Fox Squirrel	Moderate	Spotted Skunk	Low
Gray Squirrel	Moderate	Badger	Low
Cottontail Rabbit	Moderate	Bobcat	Low
Mink	Moderate	Bobwhite Quail	High
Beaver	Moderate	Mourning Dove	Moderate
Muskrat	High	Wild Turkey	High
Opossum	High	Woodcock	High
Raccoon	High	Common Snipe	Low
Coyote	Moderate	Woodchuck	High
Gray Fox	Moderate	Crow	High
Red Fox	Moderate	Wood Duck	High

[1]Current population in area of impoundment. Estimates are based on assessment of present habitat and on comparisons with other areas of Missouri. It is noted that population size is generally a function of the quantity and quality of suitable habitat.

c. Cottontail Rabbit: Inundation of the bottomlands will limit rabbit production in the project area. In addition to having the most fertile soils, this area, with its scattered agricultural units, provides the variety of successional stages and interspersion of habitat types that are essential for maximum rabbit production.

d. Woodchuck or Groundhog: Woodchucks will be reduced in the project area due to the elimination of the bottomland agricultural areas that create open space that support the growth of succulent herbaceous materials that are used as food by woodchucks.

4.2.3.2 Impacts on Furbearers

a. Mink: The mink will continue to occur along the shores of the reservoir, but their numbers in the project area will be reduced.

b. Beaver: Beaver will be greatly reduced in the project area by the inundation of the bottomland hardwoods that are their preferred food.

c. Muskrats: Muskrats will also be greatly reduced in the project area. Fluctuations in the lake will prevent them from building lodges and the rocky soil will inhibit the digging of burrows along the lake shore. Their bottomland food sources will also be greatly reduced.

d. Opossum: Opossum populations will be reduced in the project area due to the inundation of cropland and the many mature trees that provide den cavities.

e. Raccoon: Raccoon populations will also be reduced in the project area due to the inundation of cropland and the loss of mature trees that provide preferred den cavities and food.

f. Coyote, Gray Fox, Red Fox, Striped Skunk, Spotted Skunk, Bobcat, and Badger: Populations of coyote, red fox, spotted skunk, and badger, species that prefer the open bottomland areas, will be reduced, although these species will remain in upland areas that have open pasture lands. Less affected will be the gray fox and bobcat, as they prefer extensive forests. The striped skunk utilizes agricultural crops and will be reduced by the elimination of the croplands.

4.2.3.3 Impact on Game Birds

a. Bobwhite Quail: The loss of the farmlands and the mix of successional stages that are found in the bottomland will reduce bobwhite quail populations in the project area, although poorer quality quail habitat will remain in the uplands.

b. Mourning Dove: Inundation of the agricultural bottomlands that provide the best dove habitat in the project area will greatly reduce the mourning dove population.

c. Wild Turkey: The agricultural bottomlands provide the open areas and supplemental food that are necessary for prime turkey habitat. Consequently, the inundation of this area will severely limit turkey populations around the project.

d. Woodcock: Inundation of the moist, alluvial flood plain which is the main feeding area for woodcock will greatly lower the woodcock population in the project area.

e. Common Snipe: This species is not presently common in the project area and occurs only as a migrant. Although the snipe may utilize the upper reaches of the reservoir, the loss of the moist, plowed agricultural lands will limit this species in the project area.

f. Waterfowl: The only common breeding species of waterfowl, the wood duck, will be severely reduced in numbers in the project area, with the change from stream-river to lake environment. The reservoir will attract migrating waterfowl and serve as a resting place; however, due to the steep topography of the area, the banks will be steep and little food will be provided for dabbling ducks. Resting habitat for migrating waterfowl in Missouri is currently not a limiting factor for waterfowl production.

g. Crows: Since the principal food of crows in Missouri is corn, the elimination of the agricultural bottomlands where corn is grown will greatly reduce crows in the project area.

4.2.4 THE IMPACT OF THE RESERVOIR ON RARE AND ENDANGERED SPECIES

This discussion is centered upon the direct impact of the reservoir on rare and endangered species. It is recognized that development in the flood plain downstream of the lake and increased development around the lake may have an adverse impact on some rare or endangered species. However, these impacts are virtually impossible to quantify and are discussed very briefly. Rare and endangered species in the basin are discussed in paragraph 2.2.7.

4.2.4.1 Plants

a. Bryophytes and Pteriodophytes: No rare or endangered bryophytes or pteriodophytes are known to occur in the project area. However, suitable habitat for several species exists in that area, and the possibility of occurrence of one or more rare species must be acknowledged.

b. Spermatophytes: Sixty-three species of rare or endangered spermatophytes occur in or near the Meramec Basin.

Three of these species have been collected in Franklin County: *Malaxis unifolia* f. *unifolia*, *Callirhoe triangulata*, and *Triosteum angustifolium* var. *eamesii*. *Malaxis unifolia* f. *unifolia* is found in woodlands and valley floors; and if it occurs in the project area, would be affected by impoundment. It should be noted that these are uncommon plants not readily recognized by many collectors; and the project area has not been intensively collected. Thus, the possibility that other rare species occur in the lake area is recognized.

4.2.4.2 Animals

a. Invertebrates:

(1) Arthropods: Potentially impacted rare arthropods include *Tinqupa pallida*, a milliped; *Hydrospyche piatrix*, a caddisfly; *Dynastes tityus*, a beetle; and *Citheronia regalis*, a moth. It is unlikely that any individuals of these species that occur in the project area would survive impoundment. It is noted that none of these species is endemic to the Meramec Basin.

(2) Mussels: Several rare mussels have been collected in the section of the Bourbeuse River that will be impounded. These include Cumberlandia monodonta, Dysnomia triquetra, Elliptio crassidens, Leptodea leptodon, Plethobasus cyphyus, Arcidens confragosus, and Lampsilis brevicula. All of these mussels will be eliminated from the lake area. The quality of the water released from the reservoir should assure that the mussel fauna downstream of the reservoir will not be adversely affected; nor should mussel species upstream from the reservoir be adversely affected. The reservoir should not result in the extirpation of any rare or endangered species of mussel from the Meramec Basin. It is recognized, however, that the reservoir will be a barrier between mussel populations upstream and downstream. In the event that one of these populations was eliminated, the reservoir would prevent recolonization by the remaining population. This would pose a greater problem to the upstream population because the downstr am population could be repopulated by mussel colonies in the Meramec or Big Rivers.

b. Vertebrates:

(1) Fish: One fish considered endangered in Missouri, the pallid shiner, has been reported from the Bourbeuse River. This species may be extirpated from the area, since all records are prior to 1945. However, if the pallid shiner exists in the Bourbeuse River, it will be eliminated or severely reduced in the impounded area.

(2) Amphibians: Three rare amphibians occur in the Meramec Basin. One of these, the wood frog, has been reported from the project area. The destruction of the wood frog habitat by the lake is probable. The reduction of habitat for any rare species is of concern; however, the basin represents the periphery of a rather large range for this species, and the project cannot be considered highly detrimental to the survival of the species.

(3) Reptiles: Two reptiles, the scarlet snake and the alligator snapping turtle, considered rare in Missouri, are known from the basin. Both species are considered very uncommon or absent from the project area, and thus the project is not expected to exert a significant influence on state wide populations. Nationally, both species have large ranges and the project will not have measurable impact on their total populations.

(4) Birds: Twenty-six species or sub-species of birds which occur in the basin are considered rare, endangered, or of undetermined status in Missouri. Of those species, only twelve winter or breed in the Basin. The remainder are considered accidental or migrant visitors. Those species which winter or breed in the basin are listed below:

Sharp-shinned Hawk
Coopers Hawk
Red-shouldered Hawk
Marsh Hawk
Northern Bald Eagle
King Rail
Bachman's Sparrow
Common Gallinule
Least Tern
Black-billed Cuckoo
Barn Owl
Long-eared Owl
Saw-whet Owl

Losses of significant habitat due to inundation may be expected for the red-shouldered hawk. This species is under consideration for inclusion in the U. S. Fish and Wildlife list of rare and endangered species. Although this project, <u>per se</u>, will not significantly affect the state or national abundance of this species, it represents a further encroachment on already limited habitat for this rare animal.

The wintering habitat of one rare bird, the northern bald eagle, will be improved by the project, but it is recognized that wintering habitat is not the limiting factor for this species.

(5) <u>Mammals</u>: Twelve species of mammals considered rare and endangered in Missouri are found, or may be found, in the basin. These are listed below:

Indiana Bat	Long-tailed Weasel
Small-footed Myotis	Spotted Skunk
Gray Bat	River Otter
Keens Bat	Red Wolf
Eastern Big-eared Bat	Mountain Lion
Black Bear	Meadow Jumping Mouse

Two of these species, the Indiana bat and the red wolf, are considered endangered nationally. The red wolf, mountain lion, and black bear, are too uncommon to assess the impacts of impoundment on those species. If they do become established in the basin, future development will undoubtedly threaten their existence. The five bats are all cave dwelling species and all may be adversely affected by the flooding of caves.

4.2.5 THE IMPACT OF THE RESERVOIR ON CAVE COMMUNITIES

Refer to paragraph 2.2.4 for a discussion of cave communities. Relatively few caves have been found in the project area. No rare or endangered species have been reported from caves in the project area. Those that may occur are listed in Table 15. The cave communities that exist in the inundated area will be destroyed. Troglobites, the true cave animals, are extremely specialized and dependent upon a very stable environment; and many will be unable to stand even periodic inundation.

Table 15 - Rare and endangered animal species that may occur in caves in the Union Lake project area (scientific names are given when no common name is used)

Invertebrates

Millipeds
*Scoterpes dentropus
*Tinqupa pallida
Zosteractis interminata

Vertebrates

Amphibians
Grotto salamander
Mammals
*Indiana bat
Small-footed myotis or least bat
*Gray bat
Keens bat
Western big-eared bat

*Indicates species has been reported from caves in Franklin County.

It is recognized that invertebrate species, some perhaps as yet unknown to science, may occur in the caves that will be inundated by Union Lake. This is true because of the endemic nature of troglobites, whose populations in a specific cave have been genetically isolated for sufficient time to form new species, and because few caves have been rigorously examined by qualified biologists. It is noted that because very few suitable caves exist in the Union Lake area, the likelihood of this occurrence is reduced.

Another impact on cave life would be caused by the increased number of people visiting the Union Lake area and the resulting development. Caves located on government-owned land will be protected and access to these caves will be limited to people with genuine interest, such as scientists and organized spelunkers. This will be necessary to protect both the cave fauna and the general public.

4.2.6 IMPACT OF THE RESERVOIR ON SPRING COMMUNITIES

The characteristic community of any spring that is inundated will be destroyed. Since most of the plant and animal species that are characteristic of springs occur there because of the constant and cool temperature, they will probably not occur in the Union Lake. One species of caddisfly, Hydropsyche piatrix, is considered rare in Missouri and may be affected. Refer to paragraph 2.2.2 for a discussion of spring communities in the Meramec Basin.

4.2.7 THE IMPACT ON UNDESCRIBED (NEW) SPECIES

It is possible that an undescribed species, that is, a species previously unknown to science, exists in the project area. However, it is very unlikely that any such species occurs only in the project area.

[illegible] to make [illegible] Lake. [illegible]

4.3.1.2 [illegible]

[illegible] attract [illegible] development. Historically, [illegible] prior to 19[illegible] selected reservoir projects [illegible] pattern of population changes in reservoir areas. [illegible] were inconclusive as to the impact of reservoirs on population [illegible] (Outdoor Recreation Resources Review Commission, 19[illegible]). [illegible] conducted on three Missouri reservoirs provides data pertinent to this discussion. In Missouri, lake counties* adjacent to Lake of the Ozarks and Table Rock - Lake Taneycomo have shown relative rises in population as compared to adjacent non-lake regions; whereas, [illegible] experienced slight downward trends in population change ([illegible], 19[illegible]). The data presented leave uncertain the outcome of population growth of lake counties, though it is of some significance to mention that population increases are more likely in older, more developed projects which are near population centers.

4.3.1.3 Socio-Economic

Changes in income are another relevant variable to investigate in assessing impacts. Many of the principles of regional growth indicate that the multiplier effect interacting with the natural resources of the area produces greater economic growth and development. Consequently, the general wealth of the area is elevated, showing in the indices of per capita income and median family income. This principle should hold true for recreation projects. Again, historical evidence is mixed, and the data is not sufficiently developed to make a conclusion. Studies of per capita income gains, a comprehensive index of increase in overall wealth, in Arkansas and Oklahoma, revealed that lake counties, in contrast to nearby

*For the remainder of this discussion the term lake county refers to a county adjacent to a reservoir. Non-lake counties are counties adjacent to lake counties, but not actually bordering a reservoir.

non-lake counties, produced greater increases in per capita income (Outdoor Recreation Resource Review Commission, 1962). However, other research contradicts these findings. Statistical evedence shows that little or no significant differences are realized in median family income, but that onl greater stratification occurs resulting in a dichotomy of both more poor and more wealthy that might be caused by the attraction of both lower and higher income groups to lake-type recreation areas (Campbell, 1972).

Retail trade is another element of importance in evaluating the viability of the recreation industry. In nearly all cases, retail trade increased more rapidly in project counties (Outdoor Recreation Resources Review Commission, 1962). This phenomenon also prevailed in more recent research. The increase is probably the consequence of increased visitation from recreation enthusiasts and has been experienced in both Oklahoma and Missouri project areas. A conclusion can be drawn that counties with recreation reservoirs do far better in terms of retail sales as compared to non-project counties.

Lake projects also seem to alter the age structure and composition of a community. There is less empirical evidence to fully evaluate this proposition, but two of three project counties for which information was available experienced notable increases in all age groups (these areas were previously discussed), but the economic value of this point is in the increase of the 65-and-over age group, which increased proportionately more than non-lake counties (Campbell, 1972). Generally, this age bracket is associated with lower income levels and may reduce the median family income of the area. This may explain the earlier contradiction of impacts on income. Yet, due to lack of sufficient comparative data, these results should be viewed with caution.

Changes in occupational mix, employment, and educational status are also important variables in weighing the impacts of reservoirs. Unfortunately, data on these factors are sparse, making a firm conclusion difficult to defend. Some information is available and will be discussed in summary form, though the reader should remember that the results are subject to further investigation. The conslusions are:

a. The evidence provided by recent research indicates that the existence of a lake does not directly effect the educational status of a county (Campbell, 1972). That is, project areas, as compared to non-project areas, showed no significant differentiation in education status over time.

b. The occupational mix of lake areas as opposed to adjacent areas did not change significantly in most cases, but a noteworthy increase in clerical, service worker, and labor categories occurred in the project counties (Campbell, 1972). These are generally local income occupation groups.

c. Next, employment data is mixed as to the impact of a reservoir. Some lake counties have shown few added employment opportunities (Campbell, 1972). Other lake counties, however, show distinct impacts of higher wage rates for those employed (Outdoor Recreation Resource Review Commission, 1962).

d. Finally, the local government tax and revenue structure appears to benefit from lake projects. It is recognized that the initial impact of lake projects may involve initial increases in public costs, but historical data indicate that this transition cost is more than recovered in the long run. It is possible that benefits will be exceeded by costs, but the preponderence of evidence points in the opposite direction. The majority of recreation regions have benefitted in the long run in terms of local government revenue as compared to without the recreation project counties (Outdoor Recreation Resource Review Commission, 1962; Campbell, 1972; [illegible], 1966). Initailly, there is a readjustment period causing short-term flucutations in general economic and governmental activity, but this is overcome in a relatively short period. Tables 16 and 17 illustrate these conslusions.

Having examined the already existing information, the impacts predicted for Union Lake are somewhat easier to understand, as well as to put forth.

Table 16 - Change in local government income and debt of lake and adjoining counties (1962-1967).

County	General Revenues: Total	General Revenues: Local Sources	General Debt
Lake of the Ozarks Counties	[illegible]	[illegible]9.6	82.6
Adjoining Counties	49.3	38.6	189.8
Pomme de Terre Counties	3[illegible].2	[illegible].2	14.3
Adjoining Counties	40.[illegible]	32.2	134.0
Table Rock-Lake Taneycomo Counties	45.3	48.1	-3.6
Adjoining Counties	42.5	2[illegible].3	49.1

Source: Campbell, 1972.

4.3.1.4 Demography and Social Characteristics

With the Union Lake project, population growth for Franklin County will probably be somewhat greater, but not substantially different than without the project. This lack of impact on the county level is due to the independent factor of regional population growth and development originating from the greater St. Louis area (St. Louis City, St. Louis County, and St. Charles County). Franklin County lies in the path of expansion ir

thrust along Interstate Highway 44. This increase will be held to the northeast corner of the county, that part closest to St. Louis and farthest removed from the project area. In the project area, the southwest quarter of the county, the project will displace 100 farm-dwelling families. Fifty-five seasonal cabins and recreation buildings will be supplanted by the project. In the lake area, development of vacation homes and recreation facilities will increase. This part of the county, though rural, has been increasing in population, but has experienced few successful attempts at development in recent years. On this sub-county or lake area scale, a predicted increase in population due to the project will be noticeable, whereas growth on the county level will be due to St. Louis expansion. Also, the population increase as a direct result of the project should consist of a large number of retired people. The project should not directly increase the median level of education for the project area, nor median family income; however, an influx of retired people may lower the median family income.

4.3.1.5 Economics

Similar to the effect on demography, the Union Lake project probably will have only a slight effect on the economy of the county, but on the sub-county scale, the major impact will be in the recreation industry and supportive commercial enterprises. Researchers have found that recreation by itself rarely provides an adequate base for a viable economy, but can provide valuable additional benefits to the local economy. A local economy can reap benefits of a recreation-oriented industry (Nathan, 19[illegible]) when it provides supplemental income to local residents; provides investment incentives and raises the value of surrounding property; augments business for small business establishments, hotels, restaurants, retail trade, etc.; increases the local tax base of the community, thus providing funds for additional municipal and social facilities; is within easy reach of a large metropolitan area, and vacation or second homes are constructed for living or recreation purposes; and generates additonal income and funds to the area from money spent in the project area by people from outside the region (multiplier effect).

Franklin County is close to the St. Louis Metropolitan Area and has the ability to draw visitors due to an attractive environment. [illegible] volume of visitors can increase commercial development and investment opportunities in the county. Also, growth of the remainder of Franklin County is stimulated by the number and the diverseness of opportunities a recreation facility provides. It is estimated that project completion will [illegible] in approximately 1,878,000 visitor days annually, and provide [illegible] recreational facilities and a good warm water fishery.

The amount of income received from outside the county depends on the volume of purchases made by customers and visitors. The money these people spend becomes income for local residents, who in turn, spend all or part of their new income locally, thus providing income for other local people. The measure of the total impact of such a process is known [illegible]

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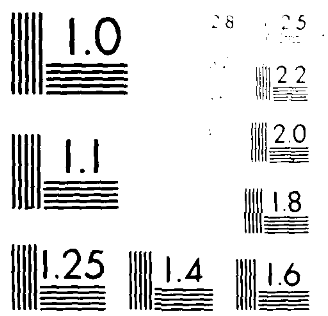
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multiplier effect. The multiplier for Franklin County has been estimated at 2.00 (Nathan, 1966). Thus, each dollar spent by visitors creates, through a cycle of respending, two (2.00) dollars of income within Franklin County. Demonstrating the impact of the multiplier effect, of the total 1,770,000 visitor days projected, approximately 1,395,211 of these will be by non-county residents. Visitor expenditure at a facility of this type is about $3.60 per visitor day. Thus, about $5,022,800 will be spent in the county by visitors. This initial amount generates a total income of $10,045,600 via the multiplier effect, and can be viewed as employment generating with the rate of growth depending on existing conditions.

In assessing impact on employment, the labor supply and the recreation industry must be examined. There are a number of peculiar aspects of the recreation industry that are of particular importance and not all are beneficial. Ordinarily, job shifting is associated with wage rates and skills. Over an extended period of time labor supply and demand tend toward balance depending upon the mobility of workers. The unemployed in rural areas are largely unskilled and less mobile. Thus, by increasing the demand for such labor, Union Lake may bring work to the currently unemployed work force in Franklin County.

While recreation may bring work to an area, the demand for the service can be unstable. This instability is due to the fact that as a consumptive item, recreation is regarded as somewhat of a luxury, subject to the fluctuations of general economic activity. Therefore, during economic recessions, recreational activities are deleted from personal budget expenditures. A second important factor is that recreation is seasonal in nature, causing seasonal employment and unemployment. This seasonality is another source of instability for the local economy, thouth it may be anticipated. Finally, because wage rates are relatively low, as compared to manufacturing or even retail trade, employment in recreation is regarded as being unfavorable. However, it should be noted that the recreation industry is expected to constitute only a small component of the local economy. Thus, other activities in the economic structure should not be adversely affected by recreation's low wage rates.

Finally, the lake project may stimulate industrial activity through two facets. First, Union Lake will provide a constant supply and substantial reserve of good quality water to the southwest corner of Franklin County, an area presently somewhat removed from such advantages. Second, the lake will provide a recreation amenity, something which is potentially attractive to an industrialist. These factors will compliment an existing good road and rail network, as well as favorable climate, already existing amenities, and large tracts of open, nearly level land. Should such a location take place, socio-economic measures such as median family income, employment and occupation mixes, and even education level would come in closer proximity to those for St. Louis County.

TABLE 17 Impact of reservoirs on county revenues.

Reservoir	County	Acres bought for reservoir	First year tax loss to county	Second year revenue from concessions	1959 revenue from concessions	Average yearly revenue from leases
Texoma	Bryan	27,419	$ 7,450	$ 760	$14,350	$ 9,655
	Marshall	60,220	16,500	3,500	24,700	21,558
	Johnston	27,366	7,400	3,120	10,400	9,521
	Love	19,247	5,250	1,850	9,200	7,195
Fort Gibson	Cherokee	13,419	4,500	5,510	12,150	8,783
	Wagoner	39,177	13,500	16,700	28,710	25,693
	Mayes	17,063	6,000	31,750	41,300	36,057
Tenkiller	Cherokee	23,706	4,500	3,710	8,420	5,863
	Sequoyah	2,849	500	650	3,870	3,100
Norfork	Baxter	33,000	2,600	2,985	10,150	9,330
Bull Shoals	Baxter	4,900	550	3,815	6,445	5,623
	Boone	13,000	1,500	7,630	15,190	10,876
	Marion	43,200	4,900	8,770	18,215	13,091

Source: Corps of Engineers, St. Louis District

4.3.1.6 Land Use

With Union Lake, economic expansion and population growth will probably be somewhat greater, but not substantially different than would occur without the project. As a result of these growths and additional flood protection, changes in land use patterns can be expected. With Union Lake, 8,574 acres of cropland and 12,[illegible]33 acres of brush and timber will be converted from private to public ownership primarily for recreational use. The project will provide a high level of protection for [illegible],020 acres on the Bourbeuse River flood plain above the mouth of the Bourbeuse River and partial protection for 21,920 acres in the lower Meramec Valley. Under current conditions, agricultural and urban land use activities are frequently hindered by major flooding problems which occur on the average about once every six years.

Changes in all land use patterns can be anticipated with the installation of Union Lake. This is particularly true for the land in Franklin and St. Louis Counties below the dam. The greater flood protection afforded to this land, most of which is presently in farm use, will reduce crop damage as well as encourage increases in residential housing construction in areas previously subject to inundation. This does not necessarily mean that such development will occur, but rather that it will become more feasible. Finally, any increase in housing or other development, or farm land, will reduce the amount of vacant, wooded, or farm land. Also, development on existing residential land may intensify.

Commercial and industrial land developments are more restricted in their patterns of location, yet both seek inexpensive land, in this case land once threatened by inundation. Commercial activities seek exposure and accessibility to the populace. Industry puts location emphasis on such factors as road and rail accessibility, nearness to supplies and market, taxes, utilities, and labor supply. Land with these qaulifications becomes more attractive due to increased flood protection. In any case, new developments in commercial and industrial activities will probably locate near major highways, such as Interstate Highway 44.

The discussion above leads to the conclusion that the protection that will be provided by the Union Lake project will create circumstances conducive to an increase in residential, commercial, and industrial land use in the flood plain downstream from the dam. The actual degree of this increased development due to the project is not known.

4.3.1.7 Socio-Cultural Impacts

Union Lake will have a profound effect on the socio-cultural make-up of the people living in the project area. The most significant

impact will occur to those 100 families who will be displaced. This impact is being partly mitigated by the relocation procedures required by Public Law 91-646. This law requires that all persons displaced by land acquisition actions be fully advised as to the relocation benefits available to them in order that there will be as little adverse impact upon them as possible. In general, the law seeks to provide persons displaced by Federal land acquisition with housing at least equal to that which they were required to vacate. Persons living in substandard housing who are displaced by a Federal or Federally-assisted project will be assisted in moving into other housing meeting minimum standards with respect to decency, safety, and sanitation. Relocation benefits are entirely separare from, and in addition to, the price paid for the property acquired. In addition to those people directly affected by relocation, many other people will lose long standing relationships with those people who are relocated.

Other impacts will result from the influx of more than 1.8 million visitors yearly as well as the recreational developments that will probably be established. The nature and magnitude of these impacts on the local people are presently unknown, but it is unlikely that the project area will retain its present semi-isolated, rural identity.

4.3.2 IMPACT OF A LACK OF PLANNING AND ZONING

Refer to paragraph 2.3.6 for a discussion of planning and zoning in the Meramec Basin.

The development that will accompany Union Lake could add substantially to the already existing problems caused by a lack of planning and zoning in the surrounding counties. The Corps of Engineers has no authority to enact, enforce, or require such laws and ordinances on non-project lands. Consequently, this duty falls to the state and local governments. The Corps of Engineers will work actively with local governmental agencies to encourage wise land-use practices. This approach has received good public acceptance at Carlyle, Rend, and Shelbyville Lakes in Illinois.

4.3.3 IMPACT ON PUBLIC HEALTH

Refer to paragraph 2.3.5 for a discussion of health factors in the Meramec Basin.

It is anticipated that the Union Lake will inundate and permanently eliminate many areas that are presently breeding flood water mosquitoes. Flood control storage in the reservoir will also be of great benefit in minimizing production of these mosquitoes in downstream areas. Because of the steep to moderately steep terrain of the reservoir basin, mosquito production is expected to be minimal during periods of normal reservoir operation. The greatest potential for production of mosquitoes appears to be in the flat, brushy flood pool areas in the upper reaches of the reservoir. Shoreline improvement, removal of flotsam, debris, and vegetative growth, and drainage of potential ponding areas can minimize production of

mosquitoes in the tributary embayments and in the flood pool zone. Chemical control measures may be required when excessive numbers of mosquitoes are produced in the upper reaches of the reservoir at flood pool stages (U. S. Department of Health, Education, and Welfare, 1966).

In addition to mosquitoes, certain other arthropods including ticks, fleas, mites, flies, and hornets and various small mammals, including rabbits, squirrels, rats, and mice are prevalent in the reservoir area, and if not controlled, may pose a definite public health hazard. The public health importance of these arthropods and mammals involves a number of human diseases including tularemia, rabies, Rocky Mountain spotted fever, tick paralysis, as well as irritation, discomfort, and annoyance caused by bites of the arthropods (U. S. Department of Health, Education and Welfare, 1966). Adequate measures will be taken to minimize or eliminate these terrestrial arthropods and small mammals at recreational sites when they pose a threat to public health.

4.3.4 IMPACTS ON OUTDOOR RECREATION

Refer to paragraph 2.3.7 for a discussion of outdoor recreation in the Meramec Basin.

4.3.4.1 Public

a. Union Lake: 5,840 acres of land will be purchased for public recreation. There will be 8 public access areas developed on this land by the Corps of Engineers, the Missouri Department of Conservation, the Missouri State Park Board, and private concessionaires; and additional 5 public access areas have been set aside for future development (See Table 18). These access areas and their facilities are listed in Table 19, and their location is shown on Plate 4 SECTION ONE. It is estimated that Union Lake will have more than 1,878,000 user-days within three years of its completion (See Table 20). The recreational activities that will be available including fishing, hunting, picnicking, camping, hiking, nature study, boating and sightseeing.

An additional 4,200 acres have been proposed for acquisition in the upper reaches of the lake. These remote locations would provide opportunities for implementing conservation practices, improved hunting and fishing access, nature study and interpretation, bird watching, and primitive camping, as well as to help protect the upper reaches from unwise development.

4.3.4.2 Private

Noser Mill Resort: This primately-owned fishing and picnicking area will be inundated by the normal pool.

4.3.4.3 Quasi-Public

a. Camp Woodland Hills: Approximately 83 acres of this church camp, owned by the Church of the Latter Day Saints, will be bought for public recreation.

Table 18. Size, development agency, and use of recreational sites for Union Lake

SITE	ACRES	DEVELOPMENT AGENCY	USE
1	90	Corps of Engineers	Administration, overlook, picnicking
2	330	Corps of Engineers Concessionaire	Picnicking, boat access
3	885	State Park Board	Campground, marina, foot trails
4	390	Corps of Engineers	Campground, boat access
5	700	Corps of Engineers Concessionaire	Picnicking, diversified
6	2,025	State Park Board	Diversified outdoor recreation including water-oriented facilities
7	560	Corps of Engineers Concessionaire	Boat access, picnicking, campground
8	15	Corps of Engineers U.S. Fish and Wildlife Service	Picnicking, bank fishing, fish hatchery
Subtotal	4,995		
A	285	Reserved for future development	
B	85	Reserved for future development	
C	210	Reserved for future development	
D	170	Reserved for future development	
E	95	Reserved for future development	
Subtotal	845		
TOTAL	5,840		

Table 19. Proposed recreational development for Union Lake by the Corps of Engineers

ITEM	SITES* 1	2	4	5	7	8
Multiple Launching Ramp Site - 4 Lanes with maneuvering apron & packing area		1				
Campsites			30		130	
Picnic Tables with concrete pad			30		130	
Picnic Tables (wood)	20	60		45	40	20
Picnic Shelters		1	1	1	1	1
Group Picnic Shelters	1	1		1	1	
Barbecue Grills	10	30	30	23	150	10
Comfort Station	1	3	2	3	11	1
Central Shower & Laundry Build.					1	
Fountain - Hydrant Combination	1	4	3	3	16	2
Trailer Dump			1		1	
Beach				1		

*Sites 3 and [illegible] will be developed by the Missouri State Park Board; figures are not available at this time.

Table 20. Estimated user-days for recreation sites operated by the Corps of Engineers at Union Lake.

Site*	Visitors Peak Day	Visitors Annual
1	1,500	57,500
2	7,900	287,600
4	5,100	186,900
5	9,700	359,500
7	13,500	503,300
8	1,300	43,200
Totals	39,000	1,438,000

*Sites 3 and 6 will be developed by the Missouri State Park Board; figures are not available at this time.

**Union Lake is expected to have 1,878,000 visitor-days annually three years after completion approximately 76 percent or 1,438,000 visitor-days are expected to occur on Corps of Engineers facilities.

b. Other Private Land: Most of the 6,600-acre tract that will be inundated by the normal pool, and the additional 15,393 acres of project lands that will be purchased, is forest and agricultural land that is suitable for hunting; however, most of that land is privately owned and the general public can only trespass by the landowner's permission.

4.3.4.4 Floating and Canoeing

Approximately 36 miles of the Bourbeuse River will be inundated at normal pool, and another 9 miles will be inundated periodically by the flood pool. Although the Bourbeuse is not nearly as popular as the upper Meramec, Huzzah, and Courtois, it provides good float fishing, especially for local residents. About 30 miles of the Bourbeuse River between the Union Lake dam and the Meramec River will be floatable more frequently because this stretch of river will not be subject to severe flooding or extreme low flow. The area inundated by the lake's normal pool represents approximately 8 percent of the total floatable stream resource in the Meramec Basin.

4.3.5 IMPACT ON ARCHEOLOGICAL SITES

Refer to paragraph 2.3.3 for a discussion of archeological sites in the Meramec Basin and the Bourbeuse River valley. Forty-two known archeological sites are located within the proposed reservoir project area. Thirty sites fall in the normal pool, 5 in the flood pool, and 7 are in the surrounding area. It is expected that there are additional undiscovered archeological sites in the area. Those sites inundated by the lake will probably be destroyed. Sites located in the normal pool will be destroyed, while sites in the flood pool will be affected to a lesser degree. Intermittent inundation and erosion expose these remains to obliteration and vandalism.

One site that will be inundated by the normal pool is the Koenig Site. This rock shelter-cliff overhang has been tested and a considerable amount of cultural material remains in the shelter. The site dates from the Woodland period, and the State of Missouri plans a study to determine if this site is eligible for nomination to the National Register of Historic Places (Traub, 1974). If it is determined that this site is eligible, the Corps will follow the procedures outlined in Executive Order 11593.

Time remains to conduct extensive archeological reconnaissance and salvage of sites located within the boundaries of the lake. The St. Louis District has had a study made to determine the adequacy of the available archeological information. This study has revealed that two years will be necessary to both make a reconnaissance of the project area and perform necessary salvage operations. The St. Louis District will fund this work.

The impact of Union Lake on the archeological resource can be considered from several aspects. If there were no project, then little effort would be expended in this area to advance our knowledge of the region.

Sites would be lost through continuing agricultural pursuits and ever expanding private developments. However, although the project does make money available for archeological studies, it does have undesirable side effects. Private and public developmental pressures are intensified around the project; the pressure to finish large salvage projects within a short time may encourage costly research decisions which later prove deleterious to the resource and; finally, the option of future exploration of a more intensive nature or with more refined techniques is closed, as many sites are irreversibly disrupted.

4.3.6 IMPACT ON HISTORICAL SITES

Of the 40 historic sites identified in paragraph 2.3.4, eight (see Table 21) are situated in either the conservation or flood control pools of the lake. All other sites are located on higher ground, and will not be subject to inundation.

Table 21 - Historic Structures in Lake Pools.

Site No.	Name or Description
6	John Door Farm
9	Young's Mill
12	Voss Place
25	Noser's Mill
27	Remmert Mine Area
30	Cemetery
31	Vallentine Cemetery
38	Cabin

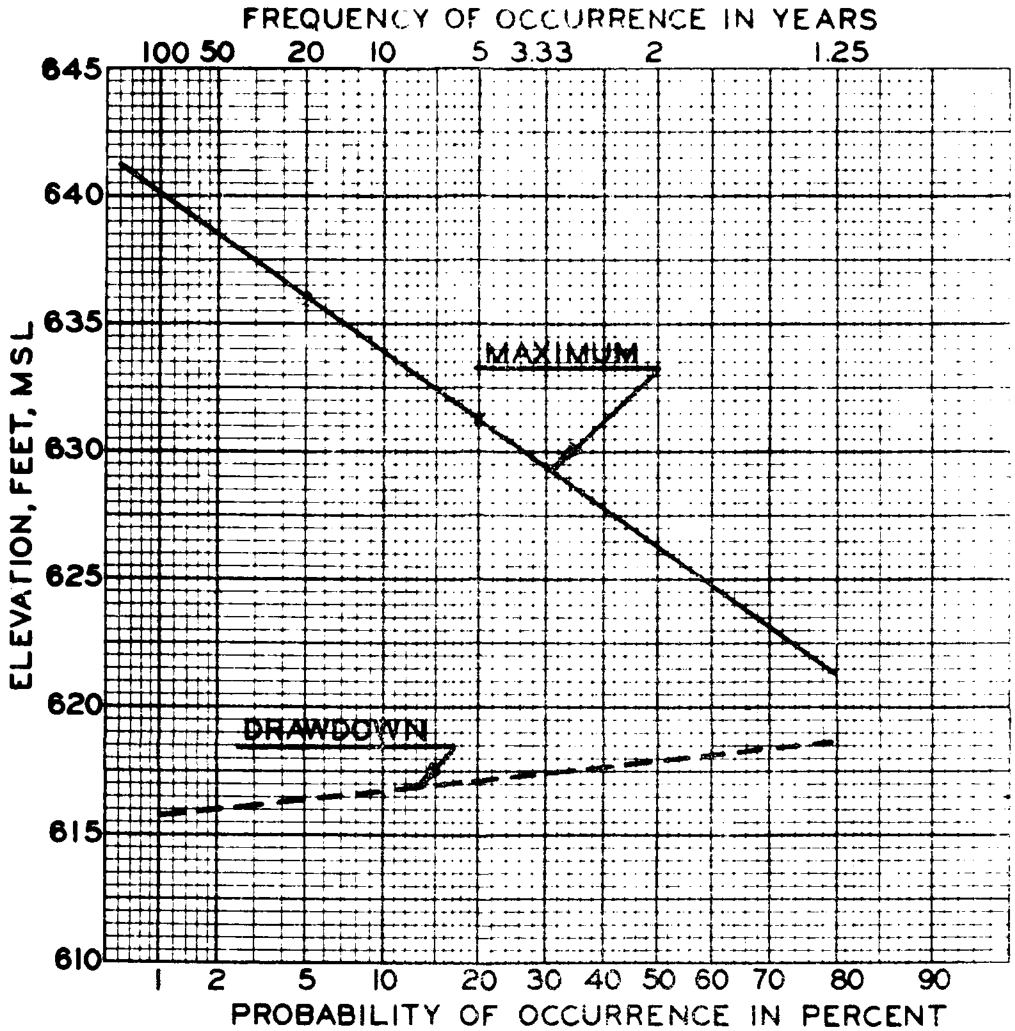
Noser's Mill, which is eligible for the National Register, will be inundated by the normal pool of the Lake. Crazy Fox Farm will be above flood pool and will not be inundated. Of those structures above the flood pool on project lands, some may be destroyed in the clearing process for making recreational sites. Unique or well-preserved structures may be used for recreational, administrative or educational purposes.

The St. Louis District will follow those procedures outlined in Executive Order 11593 for Noser's Mill to determine possible mitigatory measures that could be developed to protect this site. The Advisory Council for Historic Preservation will be consulted during this process.

4.3.7 IMPACT ON TRANSPORTATION

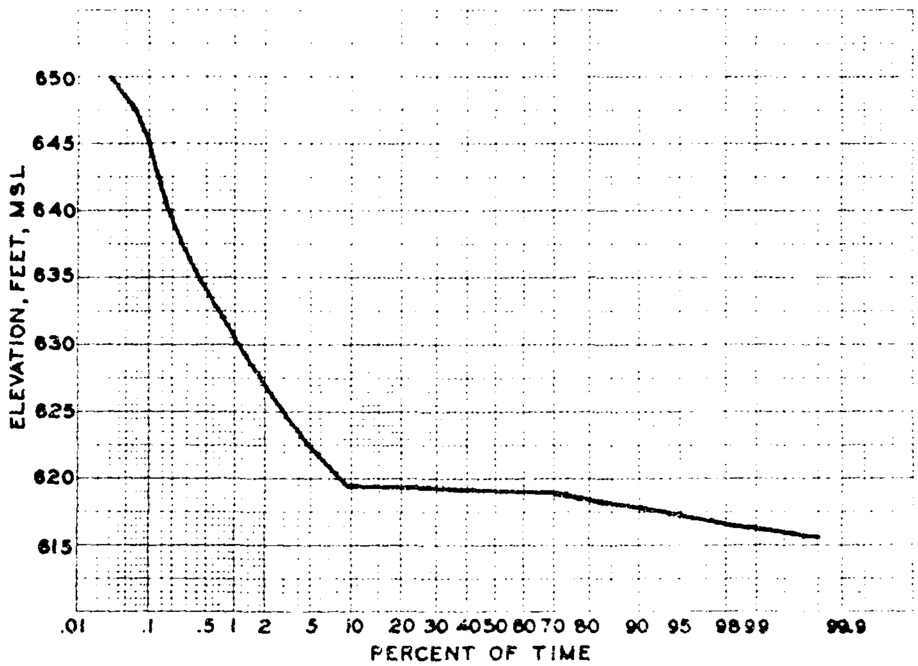
The expected annual visitation of 1,878,000 recreationists within the first three years of project life combined with the more than three million visitors expected at Meramec Park Lake will put a strain on the present highway system, especially on Interstate 44 and U.S. 50. Pressure will be especially high during the summer months at the beginning and end of a weekend. When recreational facilities are fully operational approximately 536,000 cars will visit the area each year. Peak day traffic will be approximately 18,000 cars. These numbers are in addition to existing traffic. The Corps of Engineers will provide adequate roadways within project lands; however, it is the State of Missouri Highway Department's responsibility to provide any additional roads that may be needed.

Figure 1. Union Lake Pool Stage Frequency Curve - 2020 Conditions.



Reference: U.S. Army Corps of Engineers
St. Louis, 1969

Figure 1A.



BOURBEUSE RIVER, MISSOURI
UNION RESERVOIR

POOL STAGE DURATION CURVE

SCALE AS SHOWN
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

5. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

5.1 GENERAL

Virtually all of the adverse impacts which cannot be avoided should the project be constructed are associated with direct inundation of project lands and associated resources. The remaining impacts could be offset by appropriate mitigatory measures, application of land manangement practices, and planning and zoning cf land use. Those unavoidable adverse impacts associated with inundation and those adverse impacts which cannot be avoided by application of appropriate management measures are discussed. No attempt is made to include a discussion of trade-offs, as this aspect is included in PART FOUR. It is also noted that the term adverse is broadly defined, recognizing that conditions which are adverse to one man's environment may not be adverse to another's. For example, some canoeists find great challenge in the swift waters of a flooding stream, while most prefer the safer and quieter conditions of streams at normal flow; and some prefer flat water conditions.

5.2 ADVERSE IMPACTS RESULTING FROM RESERVOIR CONSTRUCTION AND OPERATION

5.2.1 CONSTRUCTION

Earthmoving and blasting operations will cause temporary air and noise pollution to the surrounding area for approximately two years. Reservoir clearing may cause air pollution, if burning is permitted. Construction activities will cause increased erosion and compaction of soils. Erosion will result in increased turbidity in the Bourbeuse River and may adversely affect some aquatic organisms. These hazards will be minimized by environmental protection provisions in construction contracts.

5.2.2 POOL FLUCTUATION

Pool fluctuation, caused by heavy rainfall or drought conditions, will adversely affect recreational pursuits on lands peripheral to the lake. However, pool fluctuations are expected to be relatively insignificant during most years, with an average annual fluctuation of about 8.3 feet.

5.2.3 SEDIMENTATION

Based upon the present rate of sedimentation, sufficient storage volume for sediment has been provided so that all project functions will continue for 100 years before impairment of these functions will begin. The Union Lake will eventually fill with sediment; however, if the present rate of sediment yield remains constant, the lake will continue to serve its authorized purposes for approximately 1,100 years.

5.2.4 WATER QUALITY

5.2.4.1 Union Lake

In general, the water quality of the lake is expected to be good; however, potential problems such as considerable odor and taste may result from algae blooms. Increases in carbon dioxide, iron, and manganese and decreases in dissolved oxygen may be expected below the thermocline.

5.2.4.2 Downstream of the Lake

Water released downstream of the dam should be of high quality. The possibility of stratification of a pollutant at a level which would be tapped by the outlet weir is recognized. The magnitude of the seriousness of such an event would depend upon the kind and amount of pollutant.

5.2.4.3 Ground Water

Union Lake could become polluted if there is an increase in human habitation around the lake without a concomitant increase in suitable sewage treatment. This is viewed as a threat to the lake and should be avoided by appropriate local action. Waterborne sewage collection with centralized treatment is considered the only positive solution to this problem.

5.2.5 SOIL PRODUCTIVITY

Approximately 8,574 acres currently devoted to agriculture will be lost to crop production. About 2,183 agricultural acres will be permanently inundated and 6,391 acres will be incorporated into other project uses.

5.2.6 MINERAL RESOURCES

It is possible that undiscovered sources of mineral deposits exist in the area to be inundated or affected by changes in the ground water level. Losses to known industries are listed below.

5.2.6.1 Sand and Gravel

The opportunity for sand and gravel recovery operations in the inundated area will be lost, and natural replenishment of sand and gravel resources downstream of the dam will be retarded. However, the poor quality sand and gravel deposits in the project area makes them of questionable economic value.

5.2.6.2 Rock Quarries

One continuous commercial quarry operated by the Weber Construction Company will be inundated.

5.2.7 SANDBARS

Lessening flood heights downstream of the reservoir may encourage establishment of woody vegetation on sandbars, thus adversely affecting recreational activities associated with sandbars.

5.2.8 CAVES

Five known caves will be affected by the reservoir. Three of these caves fall within the normal pool area, and two fall in the flood pool area. The esthetic, geological, and biological features associated with those caves that fall within the normal pool area will be lost. The impacts on caves in the flood pool area will be directly related to frequency and duration of flooding.

5.2.9 SPRINGS

Three known springs will be affected by the reservoir. One of these falls in the normal pool area and its biological, esthetic, and geological aspects will be lost. The two springs which fall in the flood pool area will be affected by the frequency and duration of flooding and possible ground water level changes.

5.2.10 STREAMS

Approximately 50 miles of streams will be inundated at normal pool elevation. About 30 miles of these streams are of sufficient size to be considered floatable. An additional 30 miles of streams will be periodically inundated by fluctuation in the flood pool.

If the spillway is used, approximately 4,400 feet of stream will be subject to flows up to 85,700 c.f.s. Erosion and resulting turbidity will occur along with the possible dislocation of trees and destruction of wildlife. The dam access road from the west will be inundated.

5.2.11 PLANKTON

The reservoir will alter the species composition of the plankton population, and will probably result in decreased species diversity after the reservoir has reached a state of equilibrium.

5.2.12 BENTHOS

A pronounced decrease in the number of species of benthic organisms is expected to occur in the inundated area. The decreases will be significant in the arthropod and molluscan groups. The diverse mussel fauna will be among those groups significantly affected; one species, Ptychobranchus occendentales, has been collected only in the reservoir area. Therefore, the project may eliminate this species from the Meramec Basin.

5.2.13 FISH

The reservoir will reduce the number of species of fish in the impounded area. Approximately 48 species, 56.6 percent of the species currently inhabiting the river, will be reduced in number or eliminated in the impounded area. Several important species of sport fishes will also be reduced in number or eliminated in the area of impoundment. They include the rock bass, several species of suckers, and the American eel.

5.2.14 TERRESTRIAL ORGANISMS

5.2.14.1 Plants

All of the plants in the area inundated at normal pool (6,600 acres) will be killed. About 1,500 acres of additional land will be subject to inundation once in every two years, and another 735 acres will be subject to inundation once in five years. This will affect the species composition of plant communities around the reservoir.

5.2.14.2 Animals

All terrestrial animals will either move out of the inundated area or be drowned. This includes those species characteristic of cave communities. Most mobile species will leave the area during clearing or impoundment. These species will be forced to compete for limited or presently occupied habitat beyond the reservoir area. Temporary increases in some local populations as a result of immigrations may be expected, however, these increases will be virtually insignificant within a few seasons. No species is expected to disappear from the area around the project, although many will be greatly reduced in number because prime habitat will be reduced. Most game species and furbearers will be adversely affected by the project. These include white-tail deer, fox and gray squirrels, cottontail rabbit, woodchuck, mink, beaver, muskrat, opossum, raccoon, bobwhite quail, mourning dove, wild turkey, woodcock, snipe and crow. A wildlife management plan will be implemented on project lands when the project is operational and this will partially offset losses to wildlife.

Filling of the flood pool in the spring will have an adverse impact on burrowing and ground nesting wildlife species.

5.2.15 RARE AND ENDANGERED SPECIES

5.2.15.1 Plants

No rare or endangered plants are known to inhabit the project area. However, a rare spermatophyte, *Malaxis unifolia* f. *unifolia*, has been collected in Franklin County and could be affected by this project. The possibility of the presence of undescribed (new) species in the project area is recognized, although the possibility that such a species would occur only in the inundated area is remote. The total acreage of forest cover in the Basin will be reduced by the project, and subsequent developments.

5.2.15.2 Animals

Several rare species of mussels are known to inhabit the area to be inundated, and they will be eliminated by the lake environment. Several other rare species of invertebrates may be eliminated from the project area. However, none of these species are found only in the project area.

One rare species of fish, three rare species of amphibians, two rare or endangered species of birds, and 12 rare species of mammals may be adversely affected by inundation. This impact may be most significant in the case of the wood frog, which has been reported from the project area.

The possibility that an undescribed (new) species of animal might occur in the project area is recognized, but is considered to be unlikely.

5.2.16 SOCIO-CULTURAL

Approximately 100 families who reside in the project area will be displaced. Although they will be paid a fair price for their property and aided in finding new homes, moving may cause physical and mental hardships.

5.2.17 RECREATION

5.2.17.1 Private-Quasi-Public

a. Noser Mill Resort: This privately-owned fishing and picnicking area will be inundated at normal pool.

b. Camp Woodland Hills: Approximately 83 acres of this church camp will be purchased for public recreation.

5.2.17.2 Canoeing and Floating

Approximately 36 miles of canoeing and float streams will be inundated.

5.2.18 ARCHEOLOGICAL SITES

Thirty known archeological sites will be inundated by the normal pool, including the Koenig site which is a possible candidate for nomination to the National Register of Historic Places, and five additional known sites will be inundated periodically by the flood pool. The St. Louis District will fund a reconnaissance and salvage operation as recommended.

5.2.19 HISTORICAL SITES

Noser's Mill, a historical site that is eligible for the National Register of Historic Places will be inundated by the normal pool. The District will consult with the Advisory Council of Historic Preservation to determine possible mitigatory measures to protect this site.

5.2.20 ESTHETICS

The reservoir will permanently inundate approximately 50 miles of attractive streams. Portions of scenic limestone bluffs will be covered with water, as will the present pastoral-woodland aspect of the area. Noise levels may be expected to increase as a result of increased automotive traffic and motorboat activities.

5.2.21 TRANSPORTATION

The project will strain the existing highway system and may necessitate additional or improved roads.

5.3 ADVERSE IMPACTS RESULTING FROM CHANGED LAND USE IN THE BASIN

All Corps of Engineers lands surrounding the reservoir will be carefully managed to prevent or reduce environmental degradation and, where feasible, to improve existing conditions.

It is recognized that the reservoir will accelerate certain types of development in the Meramec Basin. Principal among these developments are recreational use around the reservoir, and further development in the flood plain below the dam. If not properly controlled by local ordinances and regulations, these developments could substantially add to the already existing problems caused by the present lack of adequate planning and zoning. Additional detrimental impacts may include increased air and water pollution, increased traffic problems, inadequate public facilities, substantial losses to wildlife habitat, loss of the rural atmosphere of the Basin, and general degradation in the esthetic qualities of the environment.

6. ALTERNATIVES

6.1 INTRODUCTION

The purpose of this section is to identify and describe the various alternatives to Union Lake. The discussion is separated into two parts; the first describes the detailed consideration given to the various alternative lake sites which were studied and lead to the selection of Union Lake (The Meramec River Comprehensive Basin Study); and the second describes the alternatives that might be considered in lieu of Union Lake.

6.2 THE MERAMEC RIVER COMPREHENSIVE BASIN STUDY

The Meramec River Basin has been the object of water resource development studies for over 42 years. The studies made prior to the Meramec River Comprehensive Basin Study of January 1964 were limited in scope and confined to the regional needs for navigation, flood control, power development, and irrigation. The Comprehensive Basin Study was the first investigation which had as its objective the formulation of a sound program for the development of water and related land resources to meet the immediate and long-term needs of the Basin in an orderly, efficient, and timely manner. To achieve this objective, inter-agency agreement was reached as to a framework plan, composed of watershed treatment of agricultural lands and forest improvement in the upper Basin, multiple-purpose storage reservoirs on the main streams and tributaries, and levees or flood plain regulations in the lower Basin. As the Comprehensive Basin Study progressed, it was determined that the short- and long-term needs of the Basin were flood control, recreation, domestic, municipal, and industrial water supply, fish and wildlife conservation, and area redevelopment. It was the conclusion of that study that these needs could be fully satisfied by a series of mainstem, headwater and tributary reservoirs, and several levee projects. Five of the reservoir projects were subsequently authorized by Congress. Union Lake is the second of those projects to be considered for construction. A discussion of the rationale leading to the selection of the Basin plan and, subsequently, Union Lake, is presented below.

6.2.1 RESERVOIR SITE CRITERIA

To satisfy the present and foreseeable future needs for water resource development in the Basin, all potential damsites, both on the main streams and tributary streams, were investigated. Previous studies, which considered numerous reservoir sites, were reviewed and supplemented by map and field reconnaissance to select possible sites that would meet the following criteria: (a) Reservoirs should permit complete development. (b) Impoundments should present no major relocation problem or unreasonable disruption to towns and communities. (c) Sites must have a suitable foundation, and embankment materials must be available within reasonable haul distance. (d) Main stream reservoirs should have sufficient capacity to contain the standard project flood in excess of bankfull capacity,

plus a joint-use pool of approximately one-third this amount. (e) Site locations should be well distributed throughout the Basin. (f) Natural scenic beauty and sites of historic interest should be preserved wherever possible. (g) Minor tributary reservoirs should not conflict with main stream impoundments retained for further study.

6.2.2 SITES CONSIDERED

6.2.2.1 Main Stream Sites

Thirty-six main stream sites with potential for satisfying the Basin's needs, as shown on Plate 1, were selected for investigation. Some of the sites overlap and are alternatives to others. A reconnaissance report was prepared on each site, describing access, foundation, embankment materials, and relocation problems in the reservoir area. Curves of area capacity versus elevation were developed for each site.

6.2.2.2 Headwater and Tributary Sites

Two-hundred and fifty-three headwater and tributary sites studied by the State of Missouri as a part of the 1949 Definite Project Report, Meramec Basin, Missouri, were also reviewed. This review included office study and field reconnaissance, These sites are shown on Plate 2.

6.2.3 SELECTION OF MOST SUITABLE SITES

6.2.3.1 Main Stream Sites

On the basis of preliminary cost studies, 20 of the 36 main stream sites were eliminated. Of the remaining 16 sites, nine were dropped from further consideration for one or more of the following reasons: (1) excessive cost of major relocations; (2) flooding of towns and communities; (3) loss of scenic or historic sites; (4) more favorable available alternatives; or (5) substantial local opposition. The seven remaining sites were selected for further study. For pertinent data see Table 1.

6.2.3.2 Headwater and Tributary Sites

Most of the 253 tributary and headwater reservoir sites were eliminated because of conflict with purposes to be served by the seven main stream reservoirs. In addition to the seven main stream reservoir sites, 24 tributary reservoir sites were retained for further study and economic analysis. Twelve of these 24 tributary stream sites have a total capacity of less than 25,000 acre-feet, and these are classified as headwater reservoirs. Pertinent data for the seven main stream sites and the 24 tributary and headwater sites are contained in Tables 1-5.

Table 1. Pertinent data - Reservoirs considered for further study.

Main stream reservoirs	Stream	River Mile	Drainage area (sq. mi.)	Flood control storage (ac.-ft.)	Frequency of protection provided (yrs.)	Joint-use storage (ac.-ft.)	Sediment storage (ac-ft.)	Net storage joint-use pool (ac.-ft.)	Total storage (ac.-ft.)
#2A Pine Ford	Big River	43.3	153*	196,700	100	88,300	[illegible],000	76,300	285,000
#5 Washington Park	Mineral Fork	5.0	160	---	---	147,200	5,600	141,600	147,200
#9 Irondale	Big River	116.5	175	23,900	[illegible]	137,100	5,800	131,300	161,000
#[illegible] Virginia Mines	Meramec River	82.4	240**	---	[illegible]	110,300	[illegible],000	101,300	110,300
#17 Meramec Park	Meramec River	107.5	1,508	581,600	[illegible]	[illegible]	18,[illegible]	[illegible]	1,000,000
#27 Salem	Meramec River	191.[illegible]	175	30,000	[illegible]	[illegible]	[illegible]	125,[illegible]	161,[illegible]
#29 Union	**Bourbeuse River**	**32.5**	**771**	**303,100**	[illegible]	**174,[illegible]00**	**13,700**	[illegible]	**477,300**
Tributary stream reservoirs									
I-1[illegible] Huzzah Creek	Huzzah Creek	24.7	112	[illegible]	[illegible]	[illegible],900	[illegible]	[illegible]	[illegible]
I-13[illegible] Courtois Creek	Courtois Creek	1[illegible]	[illegible]	[illegible],600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible]1 Peavine Creek	Peavine Creek	15.[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Little Dry Fork Creek	Little Dry Fork Creek	[illegible]	[illegible]	---	---	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] West Fork Huzzah Creek	West Fork Huzzah Creek	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Spring Creek	Spring Creek	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Terre Bleue Creek	Terre Bleue Creek	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Red Oak Creek	Red Oak Creek	[illegible]	[illegible]	---	---	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Little Bourbeuse River	Little Bourbeuse River	[illegible]	[illegible]	---	---	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Brush Creek	Brush Creek	[illegible]	[illegible]	---	---	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Bourbeuse River	Bourbeuse River	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
I-[illegible] Fenton Creek	Fenton Creek	[illegible]	[illegible]	[illegible]	[illegible]	2,[illegible]	[illegible]	[illegible]	[illegible]
Headwater reservoirs									
H-[illegible] Dry Creek	Dry Creek	[illegible]	[illegible]	1,[illegible]	50	900	[illegible]	[illegible]	[illegible],750
H-[illegible] Cabanne Course	Cabanne Course	[illegible]	[illegible]	---	---	[illegible],080	650	[illegible]	[illegible],080
H-5A Brady Creek	Brady Creek	[illegible].2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	950
H-[illegible] Birch Creek	Birch Creek	[illegible]	[illegible]	---	---	[illegible]	[illegible]	[illegible]	[illegible],760
H-[illegible] Little Indian Creek	Little Indian Creek	[illegible]	[illegible]	[illegible]	[illegible]0	[illegible]	[illegible]	[illegible]	[illegible]
H-[illegible] Bates Creek	Bates Creek	[illegible].7	[illegible]	1,[illegible]	[illegible]	810	[illegible]	[illegible]	[illegible]
H-10A Lost Creek	Lost Creek	[illegible]	[illegible]	[illegible]	50	57[illegible]	[illegible]	[illegible]	1,[illegible]
H-1[illegible]A Winsell Creek	Winsell Creek	[illegible]	[illegible]	1,[illegible]	[illegible]	1,1[illegible]	82[illegible]	[illegible]	[illegible]
H-1[illegible]A Boone Creek	Boone Creek	[illegible]	[illegible]	[illegible],170	50	1,[illegible]	1,[illegible]	[illegible]	[illegible],580
H-15 Big River	Big River	1[illegible]	[illegible]	700	[illegible]	1,[illegible]	870	1,[illegible]	[illegible]
H-[illegible]1 Dry Fork Creek	Tributary of Dry Fork Creek	[illegible]	[illegible]	---	---	1,760	510	1,[illegible]50	1,760
H-[illegible]0 Coonville Creek	Coonville Creek	[illegible]	[illegible]	---	---	900	380	[illegible]	900

* Excludes Washington Park and [illegible]
** Excludes Meramec [illegible]

Table 2. Main stream reservoir data sheet.

	Pine Ford (2A)	Washington Park (5)	Irondale (9)	Virginia Mines (40)	Meramec Park (17)	Salem (27)	Union (29)
Top dam elevation	[illegible]	737	887	[illegible]	736	[illegible]	683
Spillway crest elevation (m.s.l.)	[illegible]	706	860	556	701	1,008	651
Joint use pool elevation (m.s.l.)	561	706	855	[illegible]	667	[illegible]	618.6
Minimum conservation pool elevation (m.s.l.) (100-year sediment capacity)	531	618	[illegible]	[illegible]	[illegible]	[illegible]	571
River bottom elevation (m.s.l.)	496	[illegible]	760	[illegible]	566	[illegible]	533
Pool areas (acres)							
Maximum spillway surcharge	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21,900
Flood control pool	[illegible]	-	[illegible]	-	[illegible]	[illegible]	12,900
Joint use pool	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,600
Minimum conservation pool	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,000
Dam dimensions							
Crest length (feet)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2,100
Base width (feet)	[illegible]	917	[illegible]	[illegible]	[illegible]	[illegible]	800
Volume (cubic yard)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2,500,000
Spillway							
Type	Chute	Chute	Chute	Chute	Chute	Chute	Chute
Length (feet)	200	200	[illegible]	200	[illegible]	[illegible]	200
Capacity (c.f.s.)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	85,200
Maximum surcharge (feet)	37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	28.5
Outlets*							
Number, size	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2-6'0"x11'0"
Maximum controlled discharge (c.f.s.)	[illegible]	800	[illegible]	8,740	[illegible]	[illegible]	4,000
Minimum controlled discharge (c.f.s.)	[illegible]	105	101	721	614	[illegible]	11

Outlets, controlled by tractor gates, are sized for diversion and have capacities exceeding bankfull capacity and minimum flow requirements.

Table 3. Tributary reservoir data sheet.

	I-30	I-15A	I-14	I-26	I-41	I-23
Top dam elevation (m.s.l.)	811	867	916	1,046	898	965
Spillway crest elevation (m.s.l.)	790	834	881	1,026	874	941
Normal pool elevation (m.s.l.)	782	806	847	1,019	853	941
Minimum conservation pool elevation (m.s.l.)(100-year sediment capacity)	771	799	837	959	850	914
River bottom elevation (m.s.l.)	745	765	805	925	825	885
Pool areas (acres)						
Maximum spillway surcharge	1,150	2,700	2,100	1,200	800	1,200
Flood control pool	950	1,600	1,250	950	450	-
Normal pool	270	620	460	630	230	950
Minimum conservation pool	170	440	310	120	200	200
Dam dimensions						
Crest length (feet)	1,745	2,170	1,655	1,300	1,770	3,050
Base width (feet)	376	581	631	686	422	540
Volume (cubic yard)	365,000	1,080,000	963,000	981,000	412,000	846,000
Spillway						
Type	Chute	Chute	Chute	Chute	Chute	Chute
Length (feet)	50	50	50	50	50	50
Capacity (c.f.s.)	12,280	30,410	33,900	11,080	16,280	16,280
Maximum surcharge (feet)	16	28	30	15	19	19
Outlets*						
Size	4'3"x5'3"	8'0"x10'0"	8'0"x10'0"	4'9"x6'0"	4'9"x6'0"	5'3"x6'6"
Maximum controlled discharge (c.f.s.)	100	610	560	135	144	178
Minimum controlled discharge (c.f.s.)	7	18	18	13	4	14

*Outlets, controlled by tractor gates, are sized for diversion and have capacities exceeding bankfull capacity.

Table 3. Tributary reservoir data sheet (cont'd).

	I-28	I-32	I-33A	I-35A	I-21	I-3F
Top dam elevation (m.s.l.)	1,124	728	797	609	416	68[illegible]
Spillway crest elevation (m.s.l.)	1,112	718	777	786	904	65[illegible]
Normal pool elevation (m.s.l.)	1,101	718	777	73[illegible]	[illegible]87	537
Minimum conservation pool elevation (m.s.l.)(100-year sediment capacity)	1,079	68[illegible]	743	756	885	8[illegible]
River bottom elevation (m.s.l.)	1,043	[illegible]65	705	[illegible]	[illegible]	5[illegible]
Pool areas (acres)						
Maximum spillway surcharge	2,10[illegible]	2,25[illegible]	1,90[illegible]	2,1[illegible]	[illegible]	5,[illegible]
Flood control pool	1,75[illegible]	-	-	-	[illegible]	2,[illegible]5
Normal pool	[illegible]	2,[illegible]5	1,45[illegible]	1,4[illegible]	[illegible]	[illegible]
Minimum conservation pool	2[illegible]	55[illegible]	23[illegible]	25[illegible]	17[illegible]	[illegible]
Dam dimensions						
Crest length (feet)	1,[illegible]	2,20[illegible]	2,700	2,4[illegible]	2,2[illegible]	3,00[illegible]
Base width (feet)	534	[illegible]	[illegible]1[illegible]	[illegible]	352	[illegible]
Volume (cubic yards)	[illegible]	[illegible]54,0[illegible]	1,092,00[illegible]	[illegible]2,000	[illegible]17,000	76[illegible]
Spillway						
Type	Earth	Earth	Chute	Chute	Earth	Chute
Length (c.f.s.)	625	1,1[illegible]	5[illegible]	[illegible]0	36[illegible]	[illegible]5
Capacity (c.f.s.)	[illegible]	[illegible]	11,0[illegible]	14,[illegible]	26,2[illegible]	14,[illegible]
Maximum surcharge (feet)	[illegible]	[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]
Outlets*						
Size	[illegible]7'[illegible]"	[illegible]'3"x7'[illegible]"	[illegible]x7'[illegible]"	6'[illegible]"	4'[illegible]"x[illegible]'0"	[illegible]x1[illegible]"
Maximum controlled discharge (c.f.s.)	22[illegible]	3[illegible]	2[illegible]	[illegible]5	11[illegible]	[illegible]
Minimum controlled discharge (c.f.s.)	1[illegible]	2[illegible]	1[illegible]	22	1	12

*Outlets, controlled by tractor gates, are sized for diversion and have capacities exceeding bankfull capacity.

Table 4. Headwater reservoir data sheet.

	H-3	H-9	H-4	H-40	H-25	H-5A	H-8	H-10A	H-6	H-11A	H-13A	H-31
Top dam elevation (m.s.l.)	635	955	683	685	1,054	555	723	1,015	543	824	818	895
Spillway crest elevation (m.s.l.)	629	948	673	675	1,044	549	717	1,006	536	818	811	885
Normal pool elevation (m.s.l.)	618	935	673	675	1,038	537	706	997	536	806	794	885
Minimum conservation pool elevation (m.s.l.)(100-year sediment capacity)	615	933	650	663	1,027	535	692	994	521	802	792	874
River bottom elevation (m.s.l.)	592	908	617	632	988	512	664	968	492	776	764	850
Pool areas (acres)												
Maximum spillway surcharge	270	210	130	60	180	100	350	120	280	270	550	260
Flood control pool	200	150	-	-	140	80	290	90	-	200	400	-
Normal pool	100	100	100	50	100	50	200	50	200	100	150	200
Minimum conservation pool	90	60	40	30	70	30	100	40	60	80	140	80
Dam dimensions												
Crest length (feet)	1,050	1,180	610	580	300	980	1,380	690	1,090	760	1,270	1,510
Base width (feet)	200	230	370	310	400	230	320	270	230	260	270	230
Volume (cubic yard)	90,200	154,900	102,800	144,400	79,600	38,200	360,300	138,000	168,000	29,000	240,200	170,500
Spillway												
Type	Earth	Earth	Chute	Chute	Chute	Earth	Earth ramp	Chute	Rock	Earth	Earth	Earth
Length (feet)	185	140	162	90	90	[illegible]	200	75	75	180	250	135
Capacity (c.f.s.)	9,600	7,800	10,000	5,775	6,620	3,345	17,200	3,775	4,400	9,400	13,500	6,500
Maximum surcharge (feet)	6.0	7.0	9.0	8.9	8.7	5.4	5.3	7.8	6.6	6.0	6.8	6.4
Outlets												
Size (diameter, inches)	36	36	36	12	24	24	24	24	24	24	24	36
Maximum controlled discharge (c.f.s.)	205	196	212	-	302	75	428	75	375	293	493	184

Table 5. Alternative multi-purpose reservoirs studies - storage cost and land requirements.

Reservoir		Project Cost (Jul 74)	Storage (Ac-Ft)	Cost Per Ac-Ft	Land Requirements Acres	Land Required Ac Per Ac-Ft
Pine Ford	2A	$ 64,700,000	285,000	$ 227.02	19,740	.069
Wash Park	5	38,208,000	147,200	259.57	7,230	.049
Irondale	9	32,700,000	161,000	203.11	10,500	.065
Virginia Mines	40	41,847,000	110,300	379.39	18,570	.168
Meramec Park	17	100,000,000	1,000,000	100.00	38,700	.039
Salem	27	33,887,000	161,200	210.22	9,580	.059
Union	29	51,500,000	477,300	108.52	23,678	.050
Total		$362,842,000	2,342,000	Avg. 154.80	127,998	Avg. .055
Huzzah Creek	I-14	$ 15,101,000	35,400	$ 426.58	5,665	.160
Courtois Creek	I-15A	15,806,000	38,000	415.99	4,500	.118
Peavine Creek	I-21	7,824,000	8,600	909.77	1,910	.222
Little Dry Fork Creek	I-23	11,075,000	12,700	872.05	2,900	.228
West Fork Huzzah Creek	I-26	9,734,000	26,000	374.38	1,730	.067
Spring Creek	I-28	10,871,000	26,000	418.12	4,520	.174
Terre Bleue Creek	I-30	8,051,000	7,100	1,133.94	2,105	.297
Redoak Creek	I-32	10,029,000	26,000	385.73	3,905	.150
Little Bourbeuse River	I-33A	11,712,000	26,000	450.46	3,510	.135
Brush Creek	I-35A	11,827,000	26,000	454.80	3,530	.136
Bourbeuse River	I-38	14,400,000	39,000	369.23	6,025	.155
Benton Creek	I-41	8,369,000	10,300	812.52	1,330	.129
Total		$134,799,000	281,100	Avg. 479.54	41,630	Avg. .148
Dry Creek	H-3	$ 953,000	2,750	346.55	840	.306
Cabanne Course	H-4	1,683,000	2,080	809.13	820	.394
Brady Creek	H-5A	823,000	950	866.32	650	.684
Birch Creek	H-6	1,888,000	2,760	684.06	1,410	.511
Little Indian Creek	H-8	2,311,000	5,960	387.75	1,980	.332
Bates Creek	H-9	1,287,000	2,240	574.55	640	.286
Lost Creek	H-10A	1,110,000	1,240	895.16	630	.508
Winsell Creek	H-11A	862,000	3,050	282.62	1,050	.344
Boone Creek	H-13A	1,730,000	5,580	310.04	2,320	.416
Big River	H-25	1,298,000	2,660	487.97	950	.357
Dry Fork Creek	H-31	1,206,000	1,760	685.23	920	.523
Coonville Creek	H-40	1,147,000	900	1,274.44	1,070	1.189
Total		$ 16,298,000	31,930	Avg. 510.43	13,280	Avg. .416
Grand Total		$513,639,000	2,655,030			

6.2.4 STORAGE REQUIREMENTS AND CAPACITIES CONSIDERED

6.2.4.1 General

Total maximum available storage at the reservoir sites (seven main stream, 12 tributary, 12 headwater) selected for further study was estimated at 2,892,000 acre-feet. After adjustments to avoid extensive railroad relocations and the inundation of Meramec Caverns, the actual storage capacity was about 2,655,000 acre-feet. Each of the sites was examined to determine its capabilit in meeting the needs for each of several purposes. This included the determination of the amount of storage required to regulate stream flow in the interest of flood control, water supply, hydro-electric power, recreation, and fish and wildlife. The need for storage at each alternative site is defined below for each of the several purposes.

6.2.4.2 Flood Control

To meet the Basin's need for flood control, combined storage amounting to 1,270,000 acre-feet would be required at the reservoir sites. Storage requirements for flood control at each of the reservoir sites are shown in Table 1. At several sites no flood control storage was required.

6.2.4.3 Water Supply

After allocation of storage requirements for flood control, approximately 1,384,000 acre-feet were available for water supply. Of the 1,384,000 acre-feet of storage remaining, 110,000 acre-feet were required for sediment storage; consequently, net storage for water supply purposes for the reservoirs amounted to 1.274,000 acre-feet.

6.2.4.4 Augmented Flow Requirements in the Lower Bas rom the Reservoir System

Based on total requirements for downstream flow regulation for water supply, the storage would provide for all water needs in the lower Basin up to the year 2050. A shortage of 315 c.f.s. was projected as a probability during the period 2050 to 2070. In order to meet this deficiency, some reallocation of flood control storage, or provision of additional storage, was required. With improved long-range weather forecasting, it probably will be found feasible to convert some flood control storage to multiple-use for river regulation.

6.2.4.5 Recreation

The Meramec Basin has adequate land resources to meet the projected needs for land-based recreational activities. With the exception of a few private lakes and minor developments along the natural streams, flat water facilities are practically non-existent. The main stream, headwater, and tributary reservoirs would provide a total water surface area of approximately 51,200 acres at joint use pool level. Recreational demands (excluding fishing and hunting) that can be met by the reservoirs were estimated the Corps of Engineers. Recreation demands were estimated to be 19,0 000,

26,500,000, and 37,000,000 recreation-days for 1970, 2020, and 2070, respectively. The reservoirs would provide 11,500,000, 16,000,000; and 26,000,000 recreation-days in 1970, 2020, and 2070, respectively. These demands are based on population growth within the zone of influence (approximately a 100-mile radius from each damsite), and reflect increased demands generated by reservoirs over and above those projected without improvements.

6.2.4.6 Fish and Wildlife

Total demands for fishing were estimated by the Corps of Engineers for 1970, and projected for selected years from 1970 through 2070. These demands were based on population growth within the zone of influence and reflected increased demands generated by the reservoirs, with an attendant improved streams fishery, over and above the demands without improvements. Reservoir and stream fishery demands were estimated at approximately 3,400,000 fisherman-days in 1970; 4,700,000 fisherman-days in 2020, and slightly less than 6,700,000 fisherman-days in 2070.

6.2.4.7 Water Power

The seven main stream sites selected for consideration were investigated to determine whether stream flow characteristics were sufficient to warrant conventional power development. The Southwestern Power Administration stated that the power costs could not be recovered by the marketing agency now, or in the foreseeable future. The Federal Power Commission agreed that justification was lacking at that time on which to base a request for authorization for con ruction of power facilities.

6.2.5 SUMMARY

In a summary report submitted by the St. Louis District, 15 June 1965, it was stated that Meramec Park, Union, and Pine Ford reservoirs, acting as a system, provide the only practical alternative development to the other reservoirs described in Table 1. This system would have the dimensions and capabilities sufficient to physically reduce flooding in the lower Meramec Basin area, as well as be able to effect important flood reductions in Mississippi River flood crests, satisfy a major portion of the recreational demands for an ever-increasing population, and yield additional flows to meet the demands for water supply and water quality control in the lower Basin area. While the upstream reservoirs recommended in the Basin report were found essential to meet the present and future needs in upper Basin area, only Irondale and I-38 reservoirs were found to be economically justified at that time. Accordingly, the other 26 lakes were dropped from consideration as alternative projects in developing the water resources ofthe Meramec Basin. The characteistics of those five projects retained are shown in Table 6.

Table 6. Characteristics of projects comprising the plan of development.

Project	Project Cost July 1974	Storage (Acre-foot)	Cost per Acre-foot	Acres * Current Design	Acres Per Acre-foot of Storage
Meramec Park	$100,000,000	1,000,000	$100.00	38,700	0.039
Union	51,500,000	477,300	108.32	23,678	0.050
Pine Ford	64,700,000	285,000	227.02	19,740	0.069
Irondale	32,700,000	161,000	203.11	10,500	0.065
I-38	14,400,000	39,000	369.23	6,025	0.155
	$263,300,000	1,962,300	Avg. $134.18	98,643	Avg. 0.050

*Figure represents total project lands required to maintain and operate project.

The average cost of storage for the five recommended and authorized projects is $134.03 per acre-foot. This compares, respectively, with $154.80, $479.54, and $510.43 per acre-foot for the average cost of all the alternative main stream, tributary, and headwater multiple-purpose projects studied.

The average land required per acre-foot of storage for the five recommended and authorized projects is 0.050 acres. This compares, respectively, with 0.056, 0.148, and 0.416 acres per acre-foot of storage for the average acreage requirements of all the alternative main stream, tributary, and headwater multiple-purpose projects considered. These comparisons illustrate that the recommended, authorized projects, which to the greatest extent possible, meet the identified water resource needs of the Meramec Basin, are also most desirable economically, and have the least impact in terms of the amount of land required.

When Union Lake is evaluated by these same standards, the cost per acre-foot of water storage is $107.27, and the land required for this unit of storage is 0.050 acres.

6.3 ALTERNATIVES OPEN FOR CONSIDERATION

6.3.1 GENERAL

Since passage of the National Environmental Policy Act of 1969, additional evaluations of alternative actions to the recommended and authorized plan for Union Lake have been necessary. These considerations are divided into nonstructural and structural alternatives, and combinations of these alternatives. They are presented below.

6.3.2 NONSTRUCTURAL ALTERNATIVES

This class of alternatives involves techniques of management which will satisfy one or more of the project objectives in a different manner than that which has been proposed and without undertaking a large-scale construction project.

6.3.2.1 Abandonment of Construction of Union Lake Project and Substitute No Alternative

The future of the project area and the whole Basin, without Union Lake or another alternative, is impossible to predict with certainty. It would depend on future actions of Federal and State legislators as well as individual landowners. However, the abandonment of the project would probably result in the following impacts: (a) The funds and manpower effort which have already been invested in the project would be lost. These constitute approximately $2,330,000 (Aug 1974). (b) There would be continued flood hazard in the lower Bourbeuse and Meramec Rivers due to the absence of flood protection measures for both urban and agricultural areas. Major floods have occurred on the average of about once every six years; however, portions of the bottomlands have experienced flooding almost annually. (c) Without the construction of Union Lake, or the implementation of another alternative, the Bourbeuse River will continue to deterioriate. Clubhouses will probably become more prevalent, and in the absence of planning and zoning, the proposed lake site may eventually become a rural slum. This has occurred on the lower Meramec River where deteriorating clubhouses, refuse along the banks, and water pollution have created an undesirable environment. (d) The waterbased recreation needs of the St. Louis Metropolitan Area would continue unsatisfied. The Bureau of Outdoor Recreation and the National Park Service evaluated the recreation needs of the Meramec Basin in Appendix M of the Comprehensive Basin Study. This document forecasts, if the project had been operative, an annual recreation attendance at Union Lake in 1970 of 1,500,000 visitor days. (e) The opportunity for a greatly expanded fishery would be foregone. (f) The need in the lower Meramec Basin for municipal and industrial water supply and water quality control, as indicated by the U. S. Department of Health, Education, and Welfare, Public Health Service in its report of December 1964, would not be met. (g) Labor that would be used in project construction and operation may, in the absence of the project, be unemployed or underemployed. The impact of the project on the local economy, which would accrue through the development of tourism and recreational industries in the Union Lake project area, would also be foregone.

(h) The opportunity to improve navigation on the Mississippi River would be foregone. (i) There would be no earthmoving or blasting operations associated with construction and, consequently, the temporary impact of air and noise pollution would be eliminated. (j) Approximately 8,500 acres would remain in agricultural production. About 2,600 of these acres would have been inundated. (k) Sand and gravel recovery in the project area would continue and the replenishment of downstream sand and gravel resources would not be affected. Five caves, 2 of which fall into the normal pool, and 3 springs, 1 of which falls in the normal pool, would not be affected. (m) The stream fishery and its associated biological communities would remain. (n) Approximately 4,000 acres of forest would not be inundated. (o) The continued productivity of a large acreage of highly productive wildlife habitat would not be lost. (p) The habitat of several rare species of mussels, three rare species of amphibians, one rare or endangered species of birds, and 12 rare species of mammals would not be destroyed. (q) Approximately 36 miles of canoe and float streams would not be eliminated. (r) Other alternative water resource developments in the area would not be foreclosed.

The no-action alternative has not been recommended because it would not supply the short and long-term needs of the Basin in terms of flood control, recreation, and water supply. In the short run most of the desirable environmental aspects of the project area would remain intact if the project was abandoned. However, because of the ever increasing residential and recreational demands of the St. Louis area, the no-action alternative would lead to the eventual loss, through uncontrolled land development along the river, of many of the environmental amenities which presently exist in the project area. Of all possible alternatives to Union Lake, no-action may prove the least desirable long-term solution from an economic, environmental and social standpoint.

6.3.2.2 Preservation of the Bourbeuse River for Recreational and Scientific Purposes

Another alternative is that of preserving the Bourbeuse River in its present state for recreational and scientific purposes. The passage of the Wild and Scenic Rivers Act (PL 90-5422) in 1968 recognized the need to preserve outstanding wild, scenic, and recreational rivers. Presently, Missouri has one unit included under the act, the Eleven Point River, and one in the list of potential additions, the Gasconade River. Also, the Current River is an Ozark Scenic River. Other rivers could be included, provided they meet two requirements: (1) the basic qualifications for classification as wild, scenic, or recreational; and (2) they obtain appropriate Federal or State legislation for preservation with approval of the Secretary of the Interior. The Wild and Scenic Rivers Act established the three classifications:

a. <u>Wild Rivers</u>: Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trails, with watersheds or shorelines essentially primitive and water unpolluted. These represent vestiges of primitive America.

b. Scenic Rivers: Those rivers or sections of rivers that are free of impoundment, with shorelines or watersheds, still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

c. Recreational Rivers: Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Under guidelines established by the Federal Government, the Bourbeuse River does not quality as a wild river because of existing access and development. However, some of the Bourbeuse River may qualify as a scenic river, and much of the river would quality as a recreational river. Under this concept, the river in the project area would be retained, as much as possible, in its existing state, and acquisition of land by fee or easement along the river's borders would make the river more accessible to fishermen, boaters, hunters, and other recreationists. Within the area designated for these classifications, development could be controlled. Within this area, channelization or impoundment would be prevented or curtailed. As a further extension of the concept, the maintenance of the river in a free-flowing state could result in the establishment of protected areas for aquatic and terrestrial habitats in and along the Bourbeuse River. It is noted that the Bourbeuse River is not as qualified for scenic/recreational river status as the upper Meramec and its tributaries, the Huzzah and Courtois Creeks. The water in the Bourbeuse is not as clear, nor is the flow as adequate for floating.

Properly managed, this plan would probably involve the least environmental change and much of the high quality environment now present would be preserved. If this plan were in effect, there would be increased recreational and developmental pressures adjacent to the recreational area, and these would tend to degrade the quality of the present environment. The plan would not provide the solution of flood control or water supply needs of the Basin; nor would it satisfy the great demand for flat water recreation in the Basin. It would, however, eliminate present and future development within floodprone areas of the recreation area.

6.3.2.3 National Recreation Area Proposals

a. Jefferson County Planning and Zoning Commission and St. Louis County Planning Commission: In 1967 a proposal was made by the above-mentioned agencies for a national recreation area in the lower Meramec Basin. The proposed area included 51 miles of the Meramec River from Pacific, Missouri to the Mississippi River, and 14.5 miles of the Big River from Byrnesville, Missouri to the Meramec River, as well as 74,800 acres of adjacent land. Planned recreational facilities included camp and picnic grounds, beaches riding and hiking trails, boat ramps, and scenic roads.

The impacts of this proposal would be similar to those that are discussed under the scenic/recreational river alternative in 6.3.2.2.

Properly managed, this plan would be of great environmental value to the St. Louis area. It would not; however, provide a solution to the flood control or water supply needs of the Basin; nor would it satisfy the great demand for flat water recreation in the Basin. It would, however, eliminate future development within floodprone areas of the recreation area. The proposal does not include the Bourbeuse River.

This proposal was superseded by a national recreation area proposal sponsored by the Bureau of Outdoor Recreation and National Park Service and is discussed below.

b. Bureau of Outdoor Recreation and National Park Service: The Bureau of Outdoor Recreation and the National Park Service proposed on 26 October 1969, the establishment of a National Recreation Area in the Meramec Basin. This facility would be along the Meramec River from its mouth to Maramec Springs Park. The area would include the river and adjacent lands, as well as Meramec State Park, the Huzzah Wildlife Area, and the proposed Corps of Engineers Meramec Park and Union Lake projects. The National Park Service would administer the section from Maramec Springs Park (river mile 168.8) to Times Beach (river mile 34.0), a distance of 134.8 miles. Local agencies would have administrative responsibility for the segment from Times Beach to the mouth of the Meramec. A commission would be established to plan a regional open space and recreation area along the Meramec River between the mouth and Times Beach. Supplemental Federal grants of up to 30 percent, in addition to the existing standard Federal grants of 50 percent, would be provided to local agencies for public acquisition or development of lands for recreation along the lower Meramec.

At a meeting held in Jefferson City, Missouri, on 4 March 1970, chaired by the Director for Missouri State Park Board, and attended by representatives of the concerned Federal and State agencies, the Director opposed the plan on behalf of the Missouri Inter-agency Council for Outdoor Recreation. An effort was made by a representative of the Bureau of Outdoor Recreation to reconcile the State objections, but without success. A new study was to be requested by the State from below the Meramec State Park to the mouth of the Meramec River. To date, this new study has not been made.

The National Recreation Area plan includes Meramec Park Lake, and the environmental impacts expected in the project area would be similar to those discussed in PART FOUR of this statement. The environmental impact of a National Recreation Area on the entire Basin is beyond the scope of this discussion; however, properly applied, the plan could be of great environmental benefit to the Basin.

6.3.2.4 Nonstructural Flood Damage Protection Measure

a. General: Nonstructural measures such as flood plain zoning, flood insurance, permanent or temporary evacuation of the flood plain, flood proofing, and early warning systems, either singly or in combination, are important alternatives in flood damage reduction considerations, principally in urban areas. While nonstructural flood damage prevention measures, if effectively implemented, would reduce the potential for increased

future damages, flood damage to existing developments would not be eliminated. The application of nonstructural flood damage protection measures do not, in themselves, involve significant environmental impacts.

b. Flood-Proofing: Many of the existing urban developments in the lower Meramec River Valley are situated so as to make flood-proofing impractical. The cost of flood-proofing the buildings or portions of the towns in the flood plain by raising the structures, eliminating the basements or construction of flood-proof foundation walls would often exceed the value of the structures protected. The development in the lower Meramec River Valley which would be influenced by the Union Lake and which needs protection consists of approximately 35,780 acres of agriculture, urban and recreation lands. Flood-proofing techniques do not provide protection to existing agricultural development as the land would still flood without stream flow regulations.

c. Flood Plain Insurance: Flood plain insurance is available under two programs - the National Flood Insurance Program and the Federal Crop Insurance Corporation. The National Flood Insurance Program was established under the Housing and Urban Development Act of 1968 to make limited amounts of flood insurance, which was previously unavailable from private insurers, available to property owners by means of a Federal subsidy. In return for this subsidy, the Act requires that State and local governments adopt and enforce land use and control measures that will guide future development of land in flood prone areas in order to avoid or reduce future flood damage. Agriculture products, such as crops and livestock are not insurable under the National Flood insurance program.

Some crops in a limited number of counties in the United States are eligible to receive insurance coverage by the Federal Crop Insurance Corporation. In Missouri, downstream from Union Lake, Franklin County is the only county within the scope of the Corporation's program. As a practical matter, the Corporation generally excludes flood plain lands from the insurance program because the risks are so great that farmers cannon afford the premiums.

d. Flood Plain Evacuation: Flood plain evacuation or the relocation of facilities which are in a flood plain to areas outside the flood plain is a means for eliminating flood damages. Land values in the Bourbeuse and Meramec River flood plains have been increasing at a rate of 10 percent per year, and it is estimated that the land and structures in the Meramec and Bourbeuse flood plains now have a value of $48,786,000 for the 28,940 acres directly involved (i.e., in the Bourbeuse Valley between Union dam and confluence of the Bourbeuse and Meramec Rivers and in the Meramec Valley below the confluence of the Bourbeuse and Meramec Rivers). Although there are instances where this alternative is useful, it is not considered practical to relocate the facilities, residences, utilities, and transportation facilities in the Meramec River flood plain. This alternative would generate vigorous opposition in the urbanized lower Meramec River Basin. The use of this alternative, in effect, negates the income-producing capability of the land. Private, taxable income is eliminated and the tax base for Government purposes is adversely affected.

e. Flood Warning System: Techniques for forecasting flood flows have, in recent years, improved in accuracy and utility. Wherever flood forecasting has been developed, flood warning systems can be established which notify flood plain occupants when flooding is likely. This enables them to remove property above the flood level, remove goods outside the flood plain, reschedule operations, move machines and equipment, etc. These measures will reduce the damages which would otherwise accrue from flooding. This alternative would not reduce the flood damage to agricultural lands. The disruption of agricultural, manufacturing, and commercial operations with the attendant costs would still occur. Damages to railroads, roads and streets, and utilities and other unmovable facilities would still occur.

f. Flood Plain Zoning: The flood plain of the Meramec River or portions thereof that are subject to frequent inundation can be zoned to prevent utilization which will result in large damages when floods occur. This does not mean that all use would be eliminated from the flood plain. Zoning would provide for the establishment of uses which would be compatible with the potential flood hazard and would minimize flood damages. Examples of the permitted uses would be grazing land, parks, and some types of playgrounds. St. Louis and Franklin Counties have zoning laws, and the St. Louis County ordinances presently provide that large areas be set aside for open space and agriculture purposes. However, there are definite problems associated with flood plain zoning. There is considerable pressure on the zoning and planning commissions for the granting of exemptions from the zoning plan as the demand for residential, commercial and industrial land increases. The planning and zoning regulations of Jefferson County have been repealed. Further, flood plain zoning would not reduce the damages to agricultural lands and existing facilities in the lower Meramec Basin.

6.3.3 STRUCTURAL ALTERNATIVES

There are several structural alternatives to Union Lake. They differ from the nonstructural alternatives in that they would require some type of construction and would have some immediate and direct impacts on the environment.

6.3.3.1 Dry Lake

The objective of a single-purpose dry lake would be to provide the same degree of flood protection as Union Lake, while leaving the river above the dam site free from permanent impoundment. A dry lake would impound flood waters behind the dam and discharge the stored flood water at a non-damaging rate not exceeding the channel capacity. This alternative could satisfy the same flood control needs as Union Lake. If such an alternative was adopted, the "dry" lake would have a normal pool of 1,000 acrea and a maximum flood pool of 9,640 acres, with a maximum fluctuation of 65 feet. (This would compare to the authorized project's normal pool of 6,600 acres, maximum flood pool of 12,900 acres and maximum fluctuation of 32 feet.) The dry lake would subject fewer acres to periodic inundation and, consequently, fewer acres would be affected. It would also subject very few miles of stream to permanent inundation. Although the dry lake would

satisfy the same flood control needs as Union Lake, it would be of very limited use for recreationists, and would not satisfy water supply demands. The cost of the dry lake alternative is $35,524,000.

6.3.3.2 Upstream Multi-Purpose Lakes

An alternative to the construction of Union Lake would be the construction of headwater and tributary lakes. The Comprehensive Basin Study identified 24 such lakes (see Tables 1, 3-5), and their capabilities are discussed below.

A combined storage capability of 1,320,000 acre-feet is required to meet the flood control needs of the Meramec Basin. A combination of all of the 24 headwater and tributary reservoirs considered feasible in the Comprehensive Basin Study would have a total storage of 313,000 acre-feet. As demonstrated in paragraph 6.2.5, the cost of this storage averages about $540.00 per acre-foot of storage for the tributary reservoirs, and about $580.00 per acre-foot of storage for the headwater sites. The total headwater and tributary sites would require 54,900 acres of land, and the cost of these 24 reservoirs would be about $138,600,000. (By comparison, Union Lake would supply 528,000 acre-feet of storage at a cost of about $89.26 per acre-foot of storage. Total land required for construction and operation of Union Lake would be 23,678 acres, and the project would cost about $47,000,000.)

The need for supplemental water supply and storage for the lower Basin by the year 2070 is estimated to about 1,180,000 acre-feet. The total storage available in these 24 lakes over and above that needed for sediment storage is about 270,000 acre-feet. Large reservoirs located further down on the main stream require 20 percent of their effective storage to make up for evaporation and transmission losses; such losses for headwater lakes would be larger. Therefore, a very conservative estimate of storage available for water supply would be 200,000 acre-feet. This would provide for only 20 percent of the lower Basin need.

The 24 tributary and headwater reservoir sites would provide approximately 12,000 acres of water surface at normal pool. This water surface would be available for recreation and would increase the range of recreational settings available to the recreationists, and would almost double the water surface available at Union Lake.

The management and operation of many widely scattered reservoir sites presents a highly complicated and expensive task, requiring provision and maintenance of many miles of additional access roads, boat ramps and other recreational facilities, as well as complicated operational procedures to synchronize the releases from numerous reservoirs to satisfy the various project purposes.

The environmental impacts attendant to the implementation of a series of headwater and tributary reservoirs would be similar in many ways to the impacts of Union Lake, as the major impacts are a result of inundation. However, almost twice as much land would be inundated. It is likely

that the widely scattered reservoirs would [illegible] private residential and recreational development throughout the Basin, and this too would further degrade the natural qualities of the area.

The [illegible] of [illegible] headwater and tributary lakes was not adopted because they [illegible] far short of satisfying the [illegible] water resource needs. Furthermore, a [illegible] of suitable additional tributary lake sites are not available to meet the total demands. If the standards for reservoir selection set in the Comprehensive Basin Study were lowered, a number of new tributary [illegible] be added, and these would increase the capability of meeting the Basin needs [illegible] would [illegible] appreciably to the economic, social, and environmental [illegible] of the project.

6.3.3.3 [illegible]

[illegible] levees to achieve flood control would require construction [illegible] both sides of the Meramec River for segments of the [illegible] between the confluence of the Bourbeuse and Meramec Rivers and the mouth of the Meramec River. The total length of levees required [illegible] at a total cost of $39,055,000. [illegible] bottomland [illegible] acres of land subject to flooding. [illegible] the flood plain downstream of [illegible] but would not be economically feasible, except in the lower [illegible] the river below Valley Park, Missouri, [illegible] 5,325 acres of developed land [illegible] from the Meramec River and the Mississippi River [illegible]. The alternative of levee protection would afford protection [illegible] flood occurring once in 200 years; to the agricultural area below [illegible], Missouri, protection against a flood with [illegible] and the Union Lake and Meramec [illegible] a flood with a frequency of 30 years. [illegible] would [illegible] protection against a 200-year flood to 7,[illegible] acres [illegible] River, and partial protection [illegible] River and the Mississippi River.)

[illegible] would consist of increased development of the flood plain, the removal of approximately [illegible] acres from agricultural or wildlife [illegible] through levee construction and rights-of-way requirements, and [illegible] and riparian communities [illegible] Meramec [illegible] impacts would be far less than [illegible].

The alternative of levee [illegible] would not satisfy the Basin's needs for water supply [illegible] and, consequently, was not recommended.

6.3.[illegible] Alternatives

Three alternatives [illegible] the needed municipal and industrial water supply [illegible] were considered. Treatment costs of Meramec River water and [illegible] River water were assumed to be equal for

the purposes of these comparisons. The alternatives are given below: (a) Transmission of Missouri River water to supply the total municipal and industrial water supply need in the year 2070. (b) A single-purpose reservoir above the mouth of the Big River capable of assuring an additional 345 million gallons per day to meet the year 2070 municipal and industrial water supply needs. (c) The transmission of a sufficient quantity of water from the Missouri River to make up the deficiency between the projected municipal and industrial demands and the available supplies.

Table 7. Costs of each alternative are compared below:

Summary of Cost Comparisons

Alternative	Year(s) Needed	Construction Cost	Annual Operation and Maintenance Cost
1. Transmitting	2020	$16,009,500	
all added needs	2025-2045-		$146,300
from Missouri	2045	27,475,500	
River	2045-2070		399,800
2. Single Purpose	2025	27,300,000	
Reservoir	2025-2070		195,000
3. Transmission of	2025	17,823,000	
Missouri River	2025-2045-		117,000
water to supple-	2045	31,102,500	
ment available	2045-2070		273,000
supplies			

Alternative No. 1 shows that sufficient water supplies to supply the area's needs will exist until 2020. An additional $16,009,500 will be required to maintain these supplies over the 2025-2045 period. From 2045-2070 further supplies must be provided to compensate for population growth and general economic development. The cost of this will be $27,475,500.

Alternative No. 2 indicates that with the single-purpose reservoir sufficient water to supply the area's needs will exist until 2025, but between 2025-2070 an additional $27,300,000 will have to be allocated to maintain adequate supplies.

Alternative No. 3 reveals that with the Missouri River supplemental project the water for the area would last until 2025; between 2025-2045, $17,823,000 more would have to be appropriated to keep pace with demand, and an additional $31,102,500 would be required to compensate for increased urbanization.

If the total construction costs are evaluated for the 2025-2070 period, alternative No. 1 would cost $43,485,000, alternative No. 2 would cost $27,300,000, and alternative No. 3 would cost $31,102,500. The single-purpose reservoir would require less expenditure and still provide adequate water supplies, although transmission of water from the Missouri River to satisfy water supply demands would have much less environmental impact. None of these alternatives would satisfy the recreational or flood control needs of the Basin.

6.3.3.5 Combination Headwater Lakes and Dry Lake

A combination of headwater lakes and a dry lake would provide flood protection to the lower Meramec River Basin, storage for water supply, water quality, and recreation.

A dry lake at the present Union Lake site would impound flood waters behind the dam and discharge the stored flood water at a non-damaging rate not to exceed channel capacity of 4,000 c.f.s. This would, in effect, provide the same degree of flood protection as Union Lake, while leaving the river above the dam site free from permanent impoundment. As discussed in 6.3.3.2., the total storage capabilities for water supply and water quality in the 24 headwater reservoirs represents about 20 percent of the basin needs. The environmental impacts of such a plan combine the impacts of a greatly fluctuating pool at the dry lake site with the impact of permanent inundation of about 12,000 acres of land at the 24 lake sites.

This alternative would eliminate the need for a large permanent impoundment for flood control, and it would partially satisfy recreational demands in the Basin. It would not, however, satisfy water supply and water quality needs in the Basin. The adverse environmental impact of such an alternative and the total costs ($190,500,000) would be much greater than that of Union Lake ($47,130,000).

6.3.4 COMBINATION OF NONSTRUCTURAL AND STRUCTURAL MEASURES

6.3.4.1 General

Various combinations of levees, small upstream flood detention reservoirs, along with nonstructural measures such as flood plain zoning, flood insurance, flood plain evacuation, and early warning systems could be used to provide for flood control, recreation, and water supply. In order to be effective as an alternative to the flood protection afforded by one large lake, these combination measures, with the exception of upstream detention reservoirs, would have to be concentrated in the reaches of the Bourbeuse and Meramec Rivers below the multi-purpose lake site. The environmental impacts would vary depending upon the combination of measures applied. A program of this kind would require a cooperative program of Federal, State, and local governmental units. Due to high costs, and separate responsibilities among Federal, State and local governmental agencies and variances in funding and enabling legislation, these

alternatives, although possible, would require extensive cooperation and coordination among agencies. Examples of such alternatives are given below.

6.3.4.2 Alternative of Upstream Flood Detention Reservoirs with Flood Plain Insurance and Zoning and Levees

This combination of structural and nonstructural alternatvies could be used to provide recreation, water supply, and reduced flood damages in the Meramec Basin. The 24 tributary and headwater sites listed in Table 1 could partially satisfy flood control, recreational, and water supply needs of the Basin. The environmental impacts of these reservoirs are discussed in 6.3.3.2.

The levee component of this alternative would consist of 54 miles of levee. The levees would protect 8,325 acres of land in the lower Meramec River flood plain, but would not be economically feasible, except in the wider flood plain below Valley Park, Missouri, where the land is urbanized. In this area, 5,325 acres of developed land could be protected at an estimated cost of $39,055,000. The agricultural areas would be protected against the 50-year floods and the urbanized areas would have 200-year protection (see 6.3.3.3).

Flood plain zoning and insurance would be the third component of this alternative (see 6.3.2.4). This component would not be specifically under the control of the contracting agency that would construct the headwater lakes and levee components. In Missouri, the initiative for the enactment of zoning laws rests with county or local governments.

The total cost of the upstream headwater detention reservoirs and the levee components is $177,655,000. The cost of implementing flood plain zoning and flood plain insurance premiums are not included. The total cost of the small reservoirs and the levees exceeds the cost of Union Lake by approximately $130,000,000. This alternate, although more expensive, does not furnish the same protection against flooding nor meet the needs of the lower Basin for water supply to the same degree as Union Lake.

The 24 headwater reservoirs would inundate nearly twice as many acres as Union Lake. (12,000 acres vs. 6,600 acres.) The impact of the levee system would be to constrict the river, thus adversely affecting aquatic and riparian communities, and the commitment of about 760 acres of land to levee rights-of-way. The nonstructural alternatives may not exert an adverse enviromental impact.

This alternative would avoid some of the adverse impacts that would be caused by Union Lake. The major impacts avoided would be: (1) Approximately 36 miles of float streams and associated stream fishery would not be lost; (2) 8,500 acres of cropland would not be lost to production; (3) four caves, including 2 in the normal pool would not be affected; (4) three springs, one of which falls in the normal pool, would not be affected.

6.3.4.3 Alternative of Preservation, Zoning, Levees and Construction of Alternate Main Stem Reservoir(s)

This combination of structural and nonstructural methods would provide water supply, reduced flood damages, and flat water recreation as well as preserve part of the Bourbeuse River.

About 65 miles of the Bourbeuse between Highway H and Union, Missouri, would be preserved as float streams similar to the Ozark National River System. One or more of the authorized main stem reservoirs would be built to partially provide flood control, water supply, and flat water recreational needs. Levees would be built to protect urban and agricultural land. Undeveloped flood prone land would be zoned for uses compatible with potential flooding such as recreation or grazing.

Establishing a scenic river on the Bourbeuse would prevent further uncontrolled development along the scenic portion of the river, although developmental pressures would increase adjacent to the preserved area. Another impact of establishing a scenic river near the St. Louis area would be increased recreational pressure. The Current River is already experiencing overuse in some areas and a study is being made to determine the river's recreational carrying capacity; a similar plan could be prepared for the Bourbeuse River.

The impacts created by an alternate reservoir, such as one on the Meramec or Big Rivers, would be similar to those described in PART FOUR. Of the other four authorized reservoirs, only Meramec Park Lake has a greater storage capacity than Union Lake (see Table 1). Union Lake has the lowest cost per acre-foot and the second lowest land requirement per acre-foot of water storage (see Table 5).

The impacts that would occur from building levees are similar to those described in 6.3.3.3.

An uncertainty of this alternative would be the zoning portion. As mentioned in 6.3.2.4, local zoning and planning commissions may be subject to considerable pressure to grant exceptions.

6.3.5 SUMMARY OF IMPACTS

Table 8 presents a summary of some measurable environmental impacts for the major alternatives mentioned above.

TABLE 8

UNION LAKE
SUMMARY OF IMPACTS

Environmental Effects	Project as Authorized	Abandon Project	Preservation of the Bourbeuse River	National Recreation Area	Flood Proofing	Flood Insurance	Relocation[1]	Early Warning System	Flood Plain Zoning	Dry Lake[2]
Terrestrial (acres)										
1) Agricultural	436,933	445,507	445,507	424,553	445,507	445,507	445,507	445,507	445,507	445,319
2) Forest	1,891,542	1,895,832	1,895,832	1,887,842	1,895,832	1,895,832	1,895,832	1,895,832	1,895,832	1,895,020
3) Man-made land (levees)	0	0	0	0	0	0	0	0	0	0
4) Urban	205,861	205,861	205,861	205,861	205,861	205,861	203,311	205,861	205,861	205,861
5) Other[3]	6,264	0	0	9,744	0	0	2,550	0	0	0
Total	2,540,600	2,547,200	2,547,200	2,528,000	2,547,200	2,547,200	2,547,200	2,547,200	2,547,200	2,546,2[illegible]
Aquatic (miles)										
1) Streams[4]										
a) Natural-floatable	410	440	440	360	440	440	440	440	440	436
b) Natural-non-floatable	840	860	860	815	860	860	860	860	860	858
c) Levee lined	0	0	0	0	0	0	0	0	0	[illegible]
Total	1,250	1,300	1,300	1,175	1,300	1,300	1,300	1,300	1,300	1,2[illegible]
2) Lakes-Public (acres)[5]										
a) Mainstream	6,600	0	0	19,200	0	0	0	0	0	1,0[illegible]
b) Headwater	0	0	0	0	0	0	0	0	0	0

TABLE 8

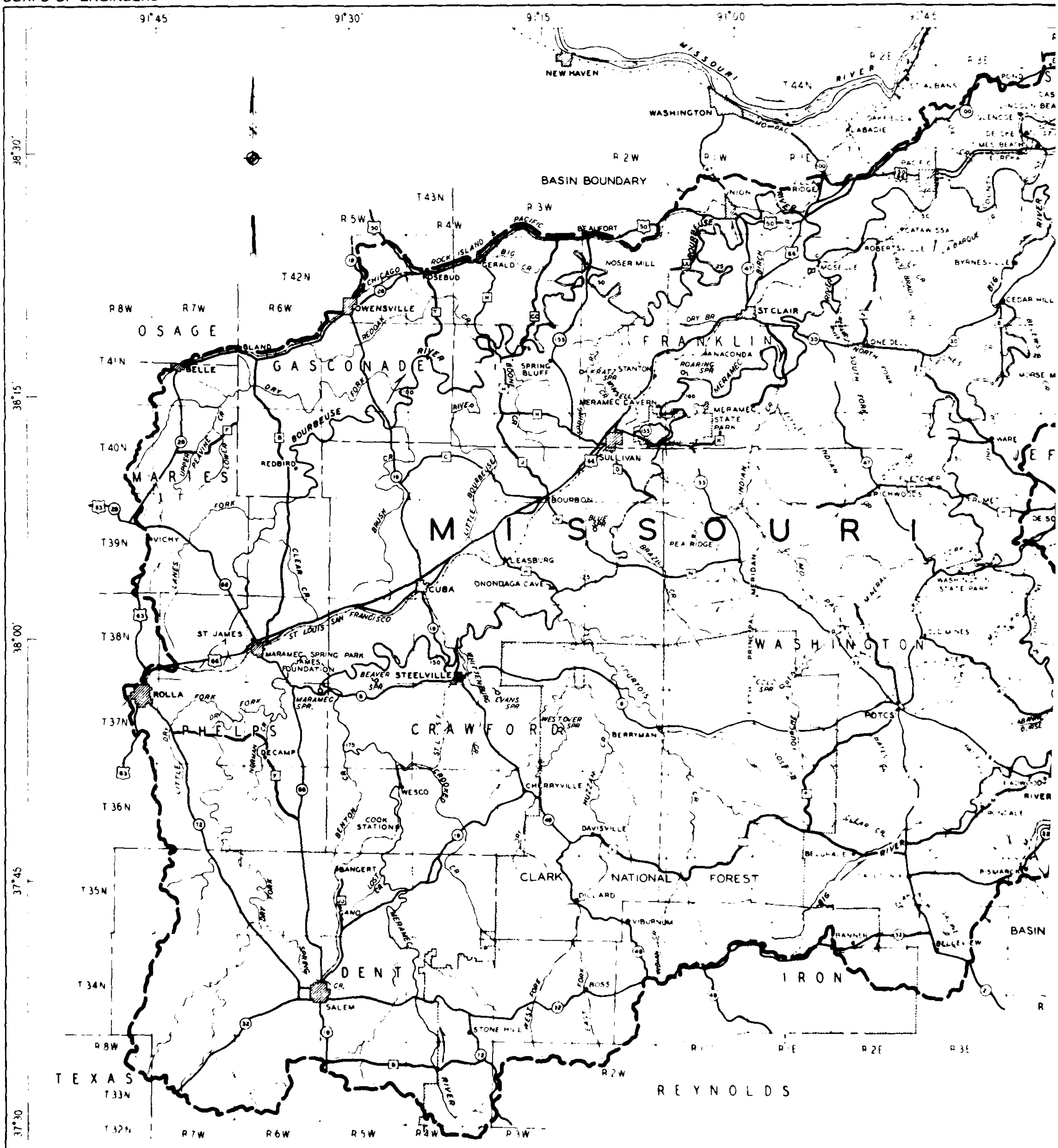
UNION LAKE
SUMMARY OF IMPACTS (Con't.)

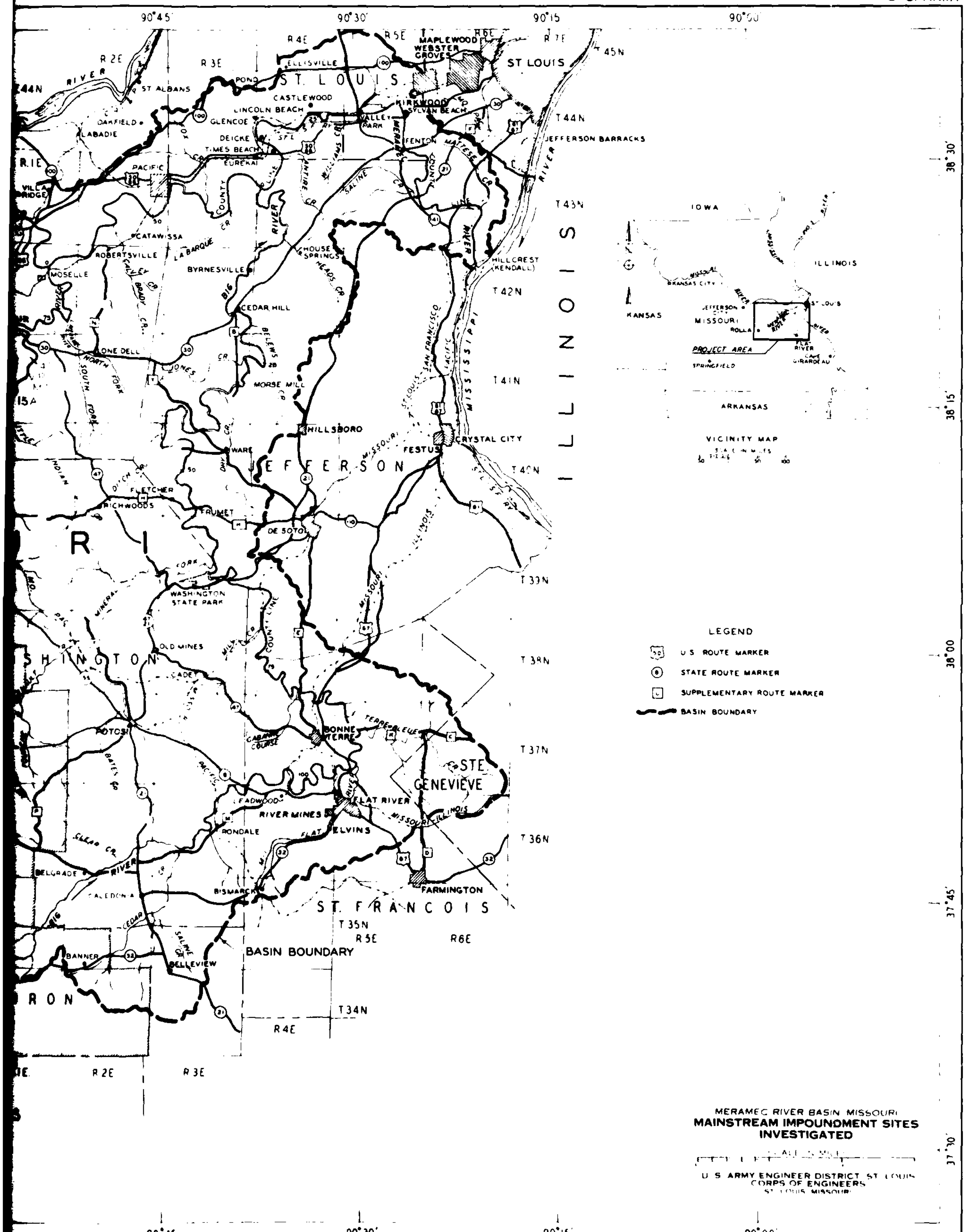
Environmental Effects	Headwater Lakes[2]	Levee[2] Protection	Water Supply Alter. No. 1	Water Supply Alter. No. 2[2]	Water Supply Alter. No. 3	Combination of Columns Nos. 9 & 10[2]	Combination of Columns Nos. 5, 8, 10, & 11	Combination of Columns Nos. 2, 8 & 11
Terrestrial (acres)								
1) Agricultural	435,185	445,364	445,507	443,965	445,507	434,998	435,043	432,984
2) Forest	1,851,253	1,895,215	1,895,832	1,889,174	1,895,832	1,850,441	1,850,636	1,846,319
3) Man-made land (levees)	0	760	0	0	0	0	760	760
4) Urban	205,861	205,861	205,861	205,861	205,861	205,861	205,861	205,861
5) Other[3]	42,901	0	0	0	0	42,900	42,900	48,676
Total	2,535,200	2,547,200	2,547,200	2,539,000	2,547,200	2,534,200	2,535,200	2,534,600
Aquatic (miles)								
1) Streams[4]								
a) Natural-floatable	440	387	440	407	440	436	387	337
b) Natural-non-floatable	788	860	860	844	860	786	788	835
c) Levee lined	0	53	0	0	0	0	53	53
Total	1,228	13,000	1,300	1,251	1,300	1,222	1,228	1,225
2) Lakes-Public (acres)[5]								
a) Mainstream	0	0	0	8,200	0	1,000	0	12,600
b) Headwater	12,000	0	0	0	0	12,000	12,000	0

[1]Estimates of terrestrial land use changes are based on 1969 land use ratios: 17.5 (agricultural); 74.4 (forest); 8.1 (urban). Source: *RETA*, 1973.
[2]Estimates of terrestrial land use changes are based on 1969 land use ratios: 18.8 (agricultural); 81.2 (forest); urban land use has not been changed.
[3]This category includes land that is required for project purposes, but the use of these lands has not been determined.
[4]Miles of stream inundated reflects normal pool conditions.
[5]All lake acreage is for normal pool.

*All figures are estimates based on the immediate impacts of each alternative. The area considered for each alternative is the entire Meramec Basin.

CORPS OF ENGINEERS

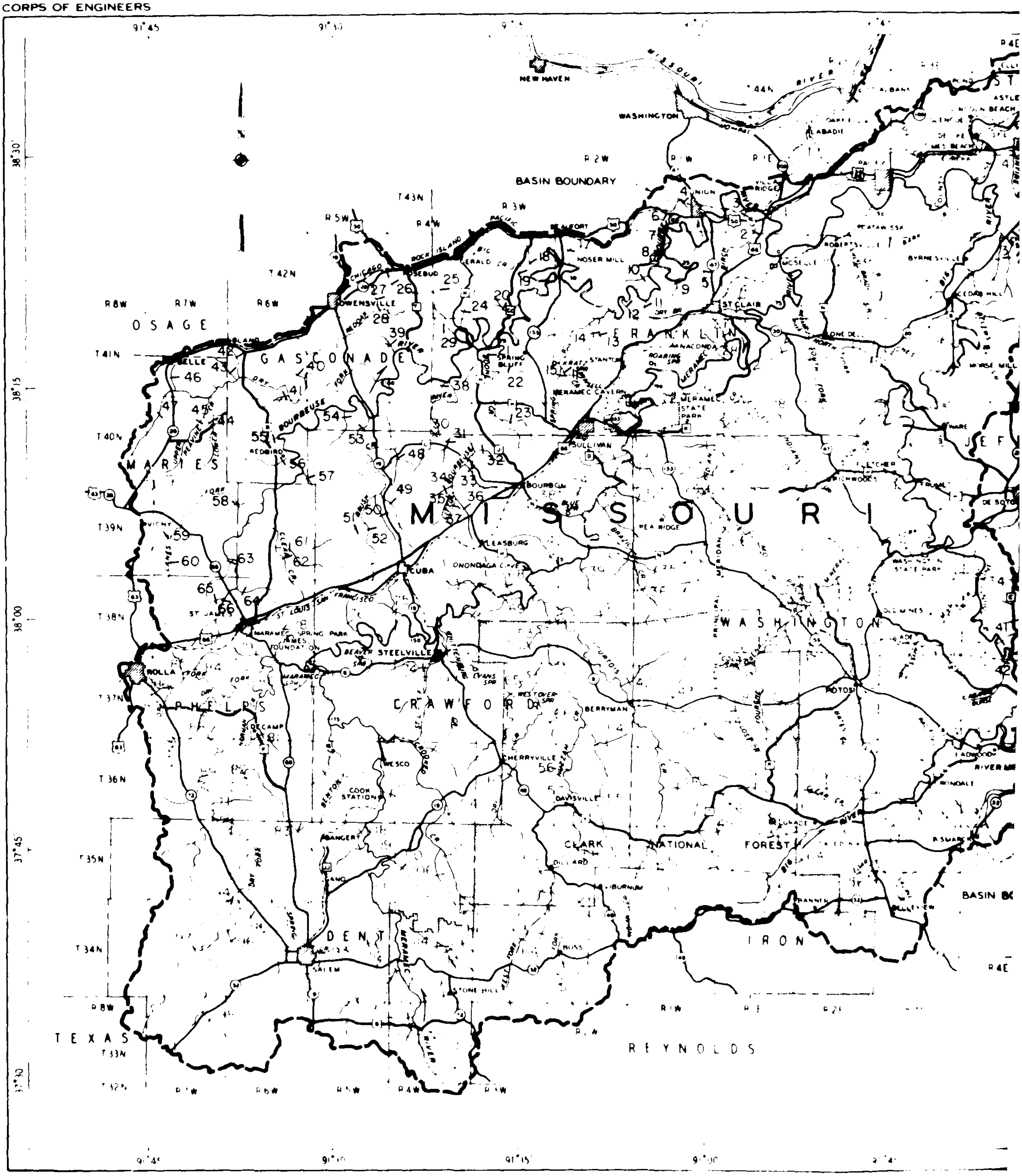




MERAMEC RIVER BASIN MISSOURI
MAINSTREAM IMPOUNDMENT SITES INVESTIGATED

U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

CORPS OF ENGINEERS



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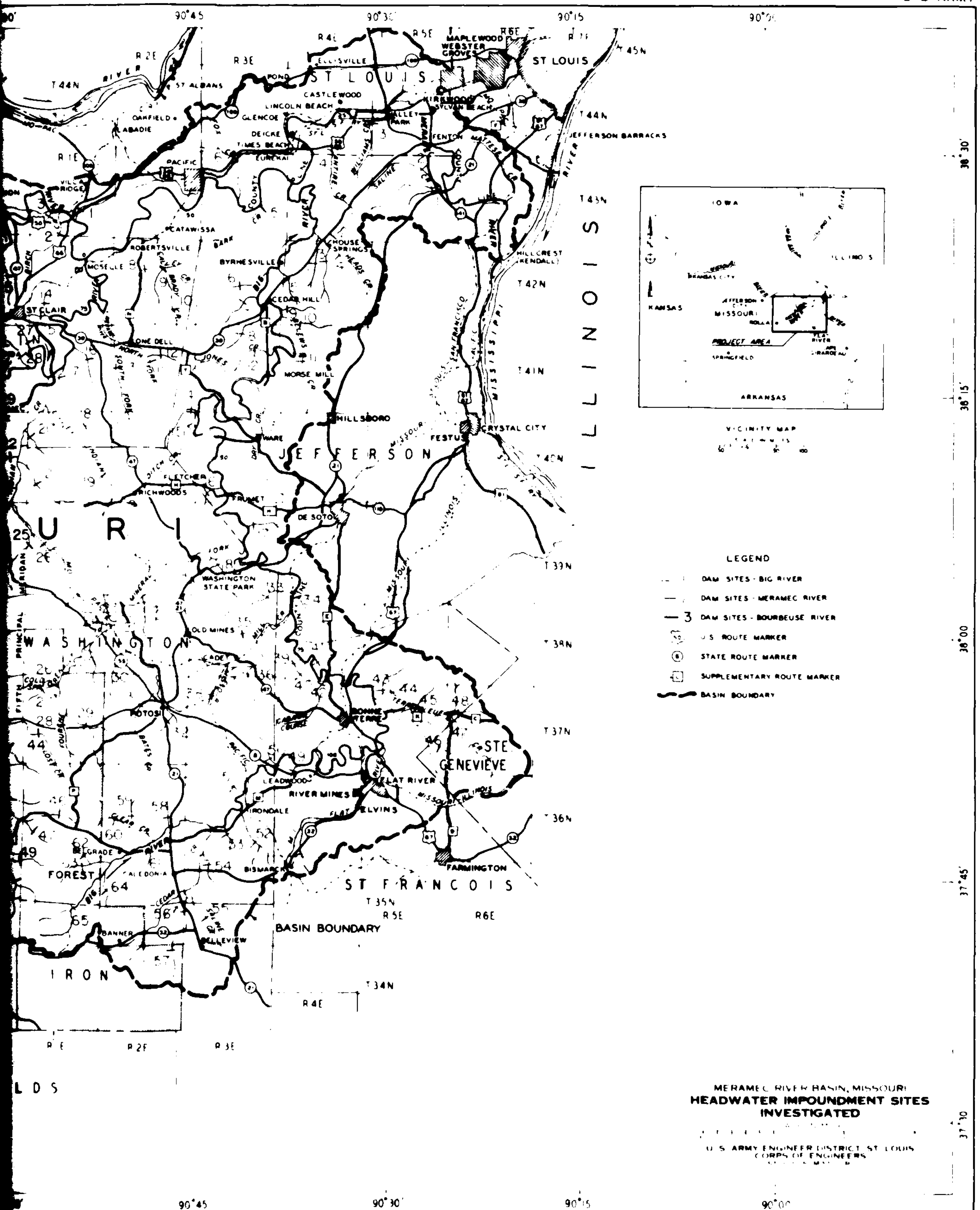

PLATE 2

7. THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Union Lake will transfer approximately 22,000 acres of private land to public use. When implemented, this project will provide a short- and long-term resource of great potential value to the people of Missouri and the United States. It is estimated that over 1,800,000 recreationists will visit the project annually. Other benefits include a high degree of flood protection to a total of 7,020 acres of land between the dam site and the confluence of the Meramec River, and partial protection to 21,920 acres adjacent to the Meramec River, below the Bourbeuse River. Other long-term benefits include water supply, low flow augmentation, fish and wildlife conservation, navigation, and area redevelopment. It is estimated that at its present rate of sedimentation, Union Lake will exist and provide a useful resource for a least 1,100 years, although its degree of usefulness, as reflected by the project's authorized purposes, will progressively decrease after the first 100 years of operation. Although the complexities involved in such predictions make them quite tenuous, it is obvious that the reservoir will serve its authorized purposes for a considerable length of time, and may logically be considered a long-range resource commitment.

The creation of Union Lake represents a long-term commitment of 6,600 acres of land that will be permanently inundated at normal pool. Although the proposed action would have no significant effect on man's life support system, it will preclude a number of ways in which this area could be used. These impacts are discussed in detail in PART FOUR, Impacts, and PART SIX, Alternatives.

The most irreversible change involves the land that will be inundated permanently by the normal pool (6,600 acres) and periodically by the flood control pool (up to 12,900 acres). This change will eliminate 2,183 acres of crop and pasture land, 50 miles of rivers and streams (about 36 miles of which are large enough to float a canoe), and a rich and productive wildlife habitat. These losses must be examined in terms of their worth to man at the present time and in the future.

The agricultural production that will be lost from the inundation of cultivated and pasture land in the project area is currently not essential to the welfare of the United States; however, when one looks at the region as well as the nation as a whole, there are many forces at work such as urbanization and the building of other reservoirs that are reducing our arable land. When and if this land will ever be needed again for food production will depend on national and international trends in population growth, advances in agricultural science, and many other interconnecting economic and cultural developments that are impossible to predict.

The free flowing river and streams that will be lost are not as essential to man as food; however, they also are resources that are rapidly disappearing. This is also true of wildlife habitats, especially those in fertile areas such as river bottoms where economics usually dictate other land uses.

The United States, and the world as a whole, is at a point where decisions must be made concerning what is desired, what is presently needed, and what is going to be needed in the future. The precursor of these decisions must be an inventory of what resources are available locally, regionally, nationally, and internationally. Unfortunately, this information is not available, nor is it possible to evaluate the impacts of countless other projects and developments that are currently taking place and will take place in the future.

The productivity and productive uses of man's environment are inextricably tied to the demands which he places on that environment. Union Lake, like the present river, has desirable short and long-term resource aspects. The authorized purposes that will be satisfied by Union Lake indicate that the short-term resource commitments involved favor the construction of the reservoir. However, there is currently no precise mechanism for the long-term evaluation of the relative desirability of a river or lake environment in this area.

8. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION, SHOULD IT BE IMPLEMENTED

The Union Lake would permanently change approximately 50 miles of free flowing, attractive streams to a clear, attractive lake. About 50 miles of productive stream fishery and stream community would be converted to a productive lake fishery and lake community. Approximately 36 miles of the inundated 50 miles are floatable, representing about 8 percent of the floatable streams in the Basin.

Of the 23,885 acres of fee and easement land required for project development, only the resources associated with those 6,600 acres which would be inundated by the normal pool are considered to be irretrieveably committed. The remaining lands will undergo resource use conversions, but these conversions are reversible. Land use conversions would include the retirement of approximately 8,574 acres of agricultural land. About 2,183 acres of this land would be inundated at normal pool, while the remainder will be incorporated into the project lands. Approximately 4,417 acres of woodland will be inundated at normal pool. Most of the project's 8,690 acres of remaining woodland will be preserved.

The loss of agricultural and forest land in the normal pool will be accompanied by a loss in highly productive plant and animal habitat. Consequently, there will be a permanent reduction in wildlife populations within the project area.

Three caves and one spring will be inundated within the normal pool area. Two additional caves and two additional springs will fall in the flood control pool area.

Noser Mill Resort, a privately owned fishing and picnicking area, will be inundated at normal pool.

Thirty known archeological sites will be flooded within normal pool area, and an additional five sites fall within the flood pool.

Noser's Mill, a historical site that is eligible for inclusion on the National Register of Historic Places, will be inundated.

Approximately 100 families who reside in the project area will be displaced.

One continuous commercial quarry operated by the Weber Construction Company will be inundated. Replenishment of sand and gravel downstream will be retarded.

9. COORDINATION WITH OTHERS

9.1 PUBLIC PARTICIPATION

9.1.1 COORDINATION LEADING TO THE COMPREHENSIVE BASIN PLAN

A number of public hearings and informational meetings were held regarding the plan for the development of the Meramec Basin. All of these meetings considered the construction of Union Lake prior to and following passage of the Flood Control Act of 1966 which modified the Union Lake project and included it in the overall plan for development of the Basin. No public meetings were held specifically regarding the environmental aspects of Union Lake. However, environmental effects were discussed at many meetings. The public hearings were as follows:

9.1.1.1 Public Hearing of 7 April 1961.

A public hearing was held by the District Engineer, U. S. Army Engineer District, St. Louis, on 7 April 1961, at St. Clair, Missouri, to obtain the views of local interests regarding the scope and need for water resource developments in the Meramec River Basin. Approximately 1,400 people were present, representing federal and state agencies, county and municipal organizations, planning bodies, and numerous individual landowners.

The District Engineer in his opening remarks emphasized that the Corps of Engineers had no plan of improvement for the Basin to present at this time, and that the primary purpose of the meeting was to obtain the views of those actively interested in developments for the Basin. Representatives of federal agencies stated that they would cooperate fully with the Corps of Engineers in preparation of the study, and they, in turn, were assured by the District Engineer that the survey would be coordinated with all agencies having an interest in the matter. State agencies, in general, cited the need for a comprehensive plan of improvement which would safeguard the natural resources in the Basin and provide the greatest overall benefits to its residents. The Director of the Missouri Conservation Commission stated that a large scale reservoir program was needed in the Meramec Basin, and that any costs allocated to fish and wildlife conservation should be non-reimbursable federal costs. The Missouri State Park Board favored a multiple-purpose reservoir on the Meramec with a fairly constant water level located so that a part of the present Meramec State Park would be benefited. It was the feeling of the Board that recreation benefits should receive full federal funding as does flood control, hydroelectric power, and navigation, and it opposed any assessment of local interests for recreation. A representative of the Meramec Basin Corporation stated that the Corporation was making a comprehensive study of the regional economic problems of the Meramec Basin and its related natural resources, and that continuation of cooperative efforts in the Meramec's

problems by all parties is needed if the soundest benefits possible are to accrue to the Basin. The mayors of numerous communities, as well as representatives of Chambers of Commerce and Rotary and Kiwanis Clubs, expressed the need for improvements which would enhance the economic conditions in the Basin.

A few organizations and landowners, some with direct interest in the Basin, expressed qualified opposition to further consideration for any developments in the Basin. The St. Louis County Planning Commission favored zoning the St. Louis County portion of the river valley. A few expressed the opinion that the river should be permitted to remain in its natural state. Others, principally bottomland farmers, contended that if dams were built, they would destroy the Basin's best farming areas. The Ozark Protective Association and the Jefferson County Farm Bureau, consisting of farmers and property owners residing within and outside the Big River Basin, a major tributary of the Meramec River, objected to any future plan that would include construction of a dam on the lower reaches of Big River. A few objected to further expenditure of federal funds for the purpose of creating a reservoir for recreational development in the Meramec Basin.

The net impressions gained from the hearing were that there has been an increased public awareness and desire for water resources development study of the Meramec Basin and that the overwhelming majority of the public concerned favored the continuation of the Corps of Engineers study and development of the Basin.

Data and information obtained at the hearing were analyzed by the Corps of Engineers in formulating a sound plan of Basin development contained in the Comprehensive Basin Study report made under authorization of the House Public Works Committee resolution adopted 6 April 1960.

During the study, more than 30 informational meetings were held throughout the Basin and surrounding towns so that the public was kept informed of developments as the study progressed. Television, radio, and newspaper coverage was also used for this purpose. In September 1962, an illustrated information bulletin describing the plan of improvement under study was distributed to over 5,000 interested persons.

After the study, a synopsis of findings was mailed to 5,000 persons, to accompany notice of public hearing held in St. Clair, Missouri, on 18 December 1963. The purpose of this hearing was to obtain the views of the public in regard to the proposed plan of improvement prior to the District Engineer's recommendations.

9.1.1.2 Public Hearing of 18 December 1963.

A public hearing was held by the District Engineer, U. S. Army Engineer District, St. Louis, on 18 December 1963, at St. Clair, Missouri,

to obtain the views of local interests in regard to the findings of the Meramec River, Missouri, Comprehensive Basin Study. A synopsis of these findings had been distributed to all of those receiving the "Notice of Public Hearing" on 4 December 1963.

Approximately 1,000 people were present, representing federal and state agencies, county and municipal organization, planning bodies, numerous individual landowners, and other interested participants.

The District Engineer reviewed the "Synopsis of Findings" and summarized the elements of the Basin plan which were presented therein. The proposed improvements were depicted on a large map of the Meramec Basin.

The first statement was made by Congressman Clarence Cannon, representative from the 9th Congressional District, which includes Franklin and Gasconade Counties, major portions of which lie within the Meramec Basin. Mr. Cannon expressed wholehearted support of the Basin plan and further stated that he had discussed his views with Congressmen Ichord, Curtis, and Karsten, who requested that he "assure them that we will cooperate with them in any way we can."

The District Engineer read a letter which had been received from Senator Stuart Symington, which stated in part:

> "I have not had an opportunity to study in detail the plan which the Corps of Engineers will propose on December 18th. Based on preliminary reports, however, it would appear the plan you will present offers a sound way to meet the present and future water needs of the Meramec River Basin, and at the same time will help assure economic growth and prosperity for this section of our country."

Mr. Clifford Summers, representing the Governor of Missouri, stated that an Advisory Committee appointed by the Governor and representing the various state agencies having a pertinent interest in the development of the Meramec Basin pledged its support of the comprehensive development of the Meramec Basin. This Committee had worked with the Corps in the development of a plan of improvement and believes that the resulting plan, as proposed, will fulfill what the Committee considers should be accomplished in river basin planning.

Colonel R. E. Smyser, Jr., Executive Director, Bi-State Development Agency, created by the States of Missouri and Illinois, read a statement recording the complete support of the Agency for the proposed plans for comprehensive development of the Meramec River.

Mr. Leo Politte, Chairman of the Meramec Basin Corporation Board, read a statement of the Board, comprised of 73 members, stating that the planning reflected by the "Synopsis of Findings" had been established in a sound and purposeful manner.

Judge Herbert Moss, presiding Judge of the Jefferson County Court at Hillsboro, read a resolution of the County Court which recorded it as being in favor of the Basin plan and, in particular, that portion of the plan pertaining to the Big River and the Starling Airport area. He further affirned the readiness of the County Government to accept responsibility and to respond to proposals in the plan which will affect Jefferson County's own view of its future development.

Mr. D. Reid Ross, Director of the St. Louis County Business and Industrial Development Commission, read a statement, which had been adopted by the Commission with the concurrence of the St. Louis County Supervisor and the Director of the St. Louis County Planning Commission supporting the plan of the Corps of Engineers in bringing water recreation facilities to the Meramec Basin and the St. Louis area.

Mayors and representatives of the towns of St. Clair, Steelville, Sullivan, Union, Valley Park, Irondale, Bourbon, Times Beach, DeSoto, Eureka, Salem, Cuba, Pacific, and Fenton read statements indorsing the plan.

Mr. C. B. Briscoe, President of the Board of Public Service, City of St. Louis, expressed the interest of the City in the economic development of the Basin.

Mr. Warren E. Hearnes, Secretary of the State of Missouri, spoke in favor of enactment of legislation which would insure Missouri's proper representation in the development of the Meramec River Basin and pledged his support and cooperation.

Mr. John F. Hallett, representing the St. Louis Chamber of Commerce, referred to an earlier report of the Chamber prepared in 1957, and stated that the plan presented today by the Corps of Engineers is considered to be in perfect harmony with the Chamber's policies.

Mr. John I. Rollings, President of the Missouri State Labor Council AFL-CIO, which is comprised of more than 1,500 local unions and over 450,000 members, stated that the "Synopsis of Findings" fulfills generally the basic thoughts expressed in a resolution by the Council, and that the proposed Corps of Engineers plan embodies a well developed program of water use, flood control, soil conservation, and recreation.

Mr. Leonard Neef, representing the United Sportsmen's League, Inc. of St. Louis, comprised of 13 individual conservation and sportsmen organizations with a combined membership of approximately 10,000, recommended that the comprehensive Basin plan for the Meramec Basin proposed by the Corps be approved at the earliest possible date to provide the best and urgently needed uses of water and land resources.

Mr. Charles H. Kroll, Chairman of the Board of Directors of the Anglers of Missouri, said: "We are hoping that this plan would come to an immediate conclusion and proceed and make fishing and recreation the number one inudstry in the State of Missouri."

The St. Louis Industrial Recreation Council, representing approximately 80,000 employees of 21 St. Louis industries, through its representative, Mr. Ross Stones, indorsed the current plan of the Corps of Engineers. Other organizations indorsing the plan were represented by officials of local unions, Chambers of Commerce, and various organizations.

Individuals supporting the proposed plan of improvement stressed the importance of providing a better economic environment for the youth of the area, citing the situation of high school graduates being unable to find commensurate employment at home. These individuals expressed their belief that the cure for this situation was to develop the water resources of the Basin to provide favorable employment and recreation opportunities. Other individuals cited the need for flood control, water supply, and pollution abatement.

Mr. Richard Horner, representing the Meramec River Association, stated: "It is the view of the Meramec River Association that the so-called 'plan of improvements' is far too large in scope, extravagant in cost, destructive of natural assets in the form of our native rivers, and not properly receptive to the primary need of the Basin which is the development of mass water recreation facilities close to the center of population, which at the same time preserves the upper valley in its natural condition." He further charged that the findings of the Corps of Engineers are not in accordance with the outline provided in the Washington University Ullman Report.

Many landowners who made their living from farming in the area were opposed to any reservoir developments, citing the loss of productive land and their opposition to being displaced.

Of the 54 oral statements, 42 were definitely in favor of the plan presented by the Corps of Engineers, 6 were against the plan, 4 favored alternate developments closer to St. Louis which would leave the clear-flowing streams undisturbed, and 2 made statements for the record which were considered to be of a general nature. Of the 94 written statements received, 73 were considered to be for the plan, 14 against, and 7 of a general nature.

9.1.2 POST AUTHORIZATION COORDINATION

Table 1 presents a partial list of meetings attended by Corps Representatives at which citizen groups were informed of the plan for development of the Meramec Basin and the contruction of Union Lake.

Table 1 Public information meetings attended by Corps of Engineers personnel

Date	Organization	Location	Subject Matter	Corps Representative
25 Feb 65	Meramec Basin Assn. Annual Spring Public Meeting	St. Louis, Mo.	Meramec Basin Plan	Col. Meanor and Staff
9 Oct 65	Meramec Basin Assn. Annual Fall Public Meeting	Meramec Caverns Stanton, Mo.	Meramec Basin Plan	Col. Meanor and Staff
22 Apr 65	Meramec Basin Assn. Annual Spring Public Meeting	St. Louis, Mo.	Meramec Basin Plan	Col. Meanor and Staff
19 Oct 66	Students U. of Mo.- Rolla	Rolla, Mo.	Meramec Basin Plan	Lee Briece
12 Nov 66	Meramec Basin Assn. Annual Fall Public Meeting	Cuba, Mo.	A Look at Tomorrow The Meramec Basin Plan	Col. Clema, D. Div. Engr., LMVD*
7 Feb 67	Rotary Club	DeSoto, Mo.	A Look at Tomorrow The Meramec Basin Plan	Col. E. R. Decker and Lee Briece
13 Feb 67	Engineers Club - Wagner Electric Co.	St. Louis, Mo.	A Look at Tomorrow The Meramec Basin Plan	Lee Briece
20 Mar 67	Bethesda Church Brotherhood	St. Louis County	A Look at Tomorrow The Meramec Basin Plan	Lee Briece

* LMVD: Lower Mississippi Valley Division, Corps of Engineers

Table 1. Public information meetings attended by Corps of Engineers personnel (cont'd).

Date	Organization	Location	Subject Matter	Corps Representative
17 Apr 67	Home Builders Assn. of Greater St. Louis	Ladue, Mo.	A Look at Tomorrow The Meramec Basin Plan	Lee Briece
4 May 67	General Meeting on Planning and zoning Crawford County, Mo.	Cuba, Mo.	Relation of Planning & Zoning to Meramec Park Lake	Briece & Cameron
20 May 67	Meramec Basin Assn. Annual Spring Public Meeting	St. Louis, Mo.	Meramec Basin Plan	W. F. Lawlor & Staff
6 Jul 67	Rotary Club	Fenton, Mo.	Meramec Basin Plan	Lee Briece
24 Aug 67	Lions Club	Concord Village	Meramec Basin Plan	Lee Briece
13- 14 Oct 67	Meramec Basin Assn. Annual Fall Public Meeting	Sullivan, Mo.	Meramec Basin Plan	LMVD & SLD*Personnel
5 Mar 68	Lions Club	Washington, Mo.	Meramec Basin Plan	Lee Briece
26 Apr 68	Meramec Basin Assn. Annual Spring Public Meeting	St. Louis, Mo.	The Meramec - A Project Worth Waiting For	Maj. Gen. R.G. McDonnel Div. Engr., LMVD & SLD Staff
14 May 68	Rotary Club	Clayton, Mo.	Meramec Basin Plan	Lee Briece
15 May 68	Rotary Club	University City	Meramec Basin Plan	Lee Briece

* St. Louis District, Corps of Engineers.

Table 1. Public information meetings attended by Corps of Engineers personnel (cont'd)

Date	Organization	Location	Subject Matter	Corps Representative
3 Dec 68	Stephan Memorial Methodist Church	St. Louis, Mo.	Meramec Basin Plan	Lee Briece
25 Apr 69	Meramec Basin Assn. Annual Spring Public Meeting	Des Peres, Mo.	Status of Meramec Basin Plan	Ltc. Wayne Alch, SLD & Staff
25 Oct 69	Meramec Basin Assn. Annual Fall Public Meeting	Sullivan, Mo.	Status of Meramec Basin Plan	Lee Briece
7, 8, 9 Aug 70	Meramec Basin Assn. Public Bus Trip	Shelbyville Lake Lake Monroe Carlyle Lake	Answering questions on Meramec Basin Plan	Lee Briece
7 Nov 70	Meramec Basin Assn. Annual Public Meeting	Fenton, Mo.	Meramec Basin Development	Maj. Gen. Andrew P. Rollins and Staff from SLD
15 Dec 70	Real Estate, Public Meeting, Meramec Park Lake	Sullivan, Mo.	Formal Presentation of Effects of Project	Col. C. N. Lefellier & SLD Staff
6, 7, 8 Aug 71	Meramec Basin Assn. Public Bus Trip	Lake Carlyle Rend Lake Lake Wappapello	Answering questions and talk on Meramec Basin Plan	Lee Briece

In addition, the Meramec Basin Corporation and its successor organization, the Meramec Basin Association, held numerous meetings throughout the Basin. The purpose of these meetings was to inform citizen groups about the plan for development of the Meramec Basin.

9.1.3 CURRENT ATTITUDES TOWARD WATER RESOURCE DEVELOPMENT

9.1.3.1 Public Opinion Survey.

In July and August of 1972, the Public Opinion Survey Unit (POSU), Business and Public Administration Research Center, University of Missouri, Columbia, conducted a survey of public attitutes toward the development of Meramec Park Lake and Union Lake. Findings in this section are abstracted from a more detailed discussion in Ryckman, et al, 1973. The survey was conducted in two areas. One, the User Region, consisted of the southeast quarter of Missouri, including St. Louis. The other area of study, the Contributor Area, consisted of Franklin, Crawford and Washington Counties which would contain Union and Meramec Park Lakes. Only the Contributor Area is considered in this discussion.

There were 299 interviews conducted in the Contributor Area. Seventy-two percent of the interviews were conducted by telephone, 24 percent were conducted in person, and 5 percent were conducted by mail. The sample was drawn from the POSU master statewide list of households chosen on a probability basis. Interviewers were instructed to address the male head of the household, if available, and otherwise the female spouse. Demographic characteristics of the Contributor Area are shown in Table 2.

Table 2. Demographic Characteristics of Contributor Area Respondents.

Adults per household: 1, 13%; 2, 69%; 3+, 18%
Age of Respondents: 18-44, 42%; 45+, 58%
Children per household: 0, 52%; 1-2, 32%; 3+, 18%
Years of school for head of house: 0-8, 46%; 9-11, 16%; 12, 28%; 13+, 9%
Years lived county: 0-9, 29%; 10-18, 15%; 19-39, 30%; 40+, 25%

The sample for this survey consisted of randomly chosen clustered households, a survey technique which is considered to be the most accurate for the collection of survey data within a reasonable budget. This sample is considered to be fairly accurate; however, as in any sample, the data reported may be unrepresentative of the target population in certain characteristics. As far as accuracy is concerned, the following rule of thumb is suggested: If this sampling process were used 20 times, 19 of those times results would be within 7 percentage points of the figures given in this report.

Of the two demographic indices that lend themselves to direct comparison with 1970 census data - age of respondent, and number of children per household - sample data falls in the zone of confidence for comparability with census figures. Although the ultimate validity of this survey cannot be known, the fact that there is comparability between sample data and census data adds support to the contention that the survey is a reasonably reliable sample of the population. Survey demographic data compared with census data is shown in Table 3 below.

Table 3. Comparison of Survey and Census Demographic Data.

	Contributor Area Survey Results	Contributor Area 1970 Census	Survey-Census Difference
Age of Respondent			
18-44	42%	49%	7%
45+	58	51	
Children per Household			
0	52%	45%	7%
1+	48	55	

9.1.3.2 Attitude Toward Proposed Lake.

Respondents were asked a total of 13 questions regarding their attitudes toward lakes. Seven of these questions are pertinent to Union Lake and are presented in Table 4. (For complete questionnaire, refer to Ryckman, et al, 1973.)

Table 4. Attitudes in Contributor Area Toward Proposed Lakes

1. How many trips to a lake, a river, or other body of water have you or any members of your household taken in 1972?

59%	No trips
18%	1-2 trips
22%	3 or more trips

2. Have you heard of the proposed Union Lake Project?

52%	Yes
47%	No
1%	Don't know

3. For this proposed project a dam will be built on the Bourbeuse River, near Union, Missouri, 45 miles southwest of St. Louis, to create a lake. Do you think the Government should or should not spend tax money to construct this dam?

43%	Should
31%	Should not
25%	Don't know

4. How strongly do you feel about your answer, very strongly or not too strongly?

47%	Very strongly
27%	Not too strongly
1%	Don't know
25%	Inapplicable

5. The Meramec River Basin Project is a large project which includes Union Lake and Meramec Park Lake and a number of other dams which would be built on the Meramec River and its streams. Do you think the Government should or should not spend tax money to construct these dams?

46%	Should
37%	Should not
17%	Don't know

6. How strongly do you feel about your answer, very strongly or not too strongly?

57%	Very strongly
25%	Not too strongly
0%	Don't know
17%	Inapplicable

7. If Union Lake, which is 45 miles southwest of St. Louis, and Meramec Park Lake, which is 60 miles southwest of St. Louis, were developed, how many times, if any, during the year do you think you or members of your household would visit either one of them?

38%	0 times
15%	1 time
15%	2-3 times
31%	4 or more times

Question 2 reveals that 52 percent of those interviewed in the Contributor Area had heard of Union Lake. Question 3 shows that 74 percent of the respondents had opinions as to whether the Federal Government should build Union Lake or not. Of those respondents expressing an opinion, 58 percent (43% ÷ 74%) were in favor of the project.

A comparison of Questions 1 and 7 reveals that although 40 percent of those interviewed in the Contributor Area reported that they visited a river, lake, or other body of water at least once in 1972, 61 percent of the respondents in the Contributor Area anticipated that they would utilize Union Lake's or Meramec Park Lake's facilities at least once a year if the lakes were developed.

Most of the respondents indicated that they felt very strongly about their opinions, although those opposed to the project were somewhat

more likely to feet strongly about the issue. It was also found that those who had heard of the project were more likely to support it. Approximately 41% of the respondents had taken a trip to a body of water in 1972. Generally, those who had taken such trips were more likely to favor the project than those who had not.

9.1.3.3 Desired Facilities.

Those respondents who indicated that they would visit a lake at least once a year were asked if some specified facilities should be included. As indicated in Table 5, the most desired facilities were picnic grounds, camping spots, playgrounds, and boating ramps and docks. The least desired facilities include commercial amusements and games, gift and souvenir shops and cottage, cabin, and motel sites. However, it should be noted that only the category of "commerical amusements" was opposed by more than half of the respondents.

Table 5. Attitudes in Contributor Area Toward Facilities by Order of Preference.

	Should be Included	Should not Be Included	No Preference
a. Picnic grounds	98%	1%	1%
b. Camping spots	95	2	4
c. Playgrounds	92	5	3
d. Facilities for boats, such as docks and launching ramps	89	7	5
e. Spaces for campers' trailers	85	11	4
f. Hiking, nature trails	78	7	15
g. Restaurants and luncheon counters	76	21	4
h. Convenience stores, laundry, etc.	74	16	10
i. Sightseeing areas such as caves and historic sites	71	13	16
j. A large lodge that rents rooms and serves meals	70	23	8
k. Small cabins, commerical motels	60	29	11
l. Gift and souvenir shops	50	43	8

m.	Land for people to buy and build cottages on	50%	41%	9%
m.	Commercial amusements such as games and rides	37	57	6

9.2 GOVERNMENTAL AGENCIES

9.2.1 COORDINATION LEADING TO THE COMPREHENSIVE BASIN PLAN

The combined efforts of all federal, state, and local agencies in the water resources field were utilized, and their views were given careful consideration in preparation of the Meramec Basin Report. The federal agencies which participated are: the Soil Conservation Service and Forest Service of the Department of Agriculture; the Public Health Service of the Department of Health, Education and Welfare; the Fish and Wildlife Service, Bureau of Outdoor Recreation, National Park Service, Bureau of Mines, and Southwestern Power Administration of the Department of the Interior; the Federal Power Commission; and the Area Redevelopment Administration of the Department of Commerce. The State of Missouri agencies which participated are: the Water Resources Board, the Division of Geological Survey and Water Resources, the Park Board, the Water Pollution Board, the Highway Commission, the Conservation Commission, the Division of Commerce and Industrial Development, and the University of Missouri Extension Service. As directed in the authorizing resolution, the study has been fully coordinated with, and has taken into account, the plans of the Meramec Basin Corporation in matters of Federal interest in the Basin. The St. Louis County Planning Commission was also consulted. The extent of this coordination and participation is reflected in the following paragraphs.

9.2.1.1 <u>U. S. Department of Health, Education, and Welfare - Public Health Service.</u>

The Public Health Service determined the municipal and industrial water supply requirements and the need for low-flow augmentation in the interest of water quality control. The U. S. Bureau of Mines, U. S. Forest Service, National Park Service, U. S. Fish and Wildlife Service, Missouri Water Pollution Board, and State Division of Geological Survey and Water Resources also assisted in this study. The Public Health Service has expressed the following views:

> ". . . reservoir storage will not be needed for municipal and industrial water supplies in the Upper Basin. In the Lower Basin, additional water will be needed by 1995 for municipal and industrial water, either from reservoir storage in the basin or from a source outside the basin.
>
> ". . . it is apparent that reservoir storage for streamflow regulation for quality control will be needed during the study period.

"Our studies to date indicate that the following reservoirs should be constructed during the next 15 years:

I-38 on Upper Bourbeuse River
Union on Bourbeuse River
Pine Ford on Big River

"We suggest that reservoirs Pine Ford and Upper Bourbeuse River have top priority, and Union second priority."

The Public Health Service also stated that the headwater reservoirs lack sufficient joint-use storage capacity to make any significant contribution to water quality control, and, consequently, it has made no comment in regard to the need for authorization of any of the headwater reservoirs.

9.2.1.2 U. S. Department of Agriculture.

United States Department of Agriculture's Meramec River Basin Report, a study of the Meramec River Basin by the United States Department of Agriculture, in cooperation with the Missouri Water Resources Board, was completed in April 1966, as authorized by Section 6, Public Law 566, 83rd Congress. The USDA agencies participating in the study were: Economic Research Service; Forest Service; and the Soil Conservation Service, and the study was coordinated with the Corps of Engineers Studies.

The USDA study included an inventory of the land and land use, changes in land use, needs for resource development, and recommendations for improved farming practices according to land capabilities. Recreation was recognized as an important land use.

The Department of Agriculture prepared interim reports which were made available to the Corps of Engineers prior to the completion of the report. The Soil Conservation Service furnishpd designs and cost estimates for the 12 headwater sites which were selected for detailed study. The Forest Service provided projections of the effects of the development of the wood industry on water requirements. A report was also submitted by the Forest Supervisor of the Clark National Forest on the impact of the Basin plan on the Clark National Forest. The interim reports, which are shown as Appendices G, H, and I in the Corps of Engineers Volume VI Comprehensive Basin Study, were as follows:

APPENDIX G - PART 1 - PHYSICAL LAND CONDITION
PART 2 - DESIGN AND COST ESTIMATES FOR HEADWATER RESERVOIRS

APPENDIX H - PLAN OF PARTICIPATION BY U.S. DEPARTMENT OF AGRICULTURE

APPENDIX I - REPORT ON FOREST RESOURCE POTENTIAL

9.2.1.3 U. S. Department of the Interior.

a. Geological Survey. This agency assisted in the water survey studies undertaken by the Missouri Water Pollution Board and participated

in a ground water program undertaken in cooperation with the Missouri State Geological Survey. Maps of the Meramec Basin, prepared by the U. S. Geological Survey, were used throughout the study.

b. Bureau of Mines. The Bureau evaluated the impact of the proposed reservoir system on the mining industry in the Basin, including the needs for water supply and the effects of mining operations on water quality. A study of economic projections and effects on water quality and water supply was furnished the Public Health Service. A report prepared by this agency, entitled "Mineral Resources and Mineral Industry of the Meramec River Basin, Missouri," was included in the Basin Study Report.

c. Fish and Wildlife Service. The Fish and Wildlife Service evaluated fish and wildlife aspects of the Basin, including effects of the plan of improvement under consideration by the Corps of Engineers. The agency recommended additional parcels of land downstream from the reservoirs and adjacent to the streams be provided as angler-use sites for float fishing. Multiple-level intakes in conduits were recommended to provide temperature and oxygen content in downstream releases suitable for warm water fisheries. The effects of flood protection and change in land use were evaluated and a request was made that specific areas be acquired to mitigate the adverse effects on wildlife. The Fish and Wildlife Service has expressed the following views in regard to priority of construction of the reservoirs.

> "We recommend that initial construction begin at Union, Pine Ford and Virginia Mines Reservoirs in descending order or priority. Large impoundments in the vicinity of the City of St. Louis are necessary to satisfy that metropolitan area's needs for water-oriented recreation associated with fish and wildlife. These sites are strategically located near major highways radiating from the City and as such their accessibility is assured. We favor early construction of Irondale Reservoir to serve the fish and wildlife resources needs of the heavily populated southeastern portion of the Meramec Basin. In addition, an impoundment in this area would help fulfill the expanding recreational requirements of the City of St. Louis.
>
> "The establishment of a small reservoir in the rugged terrain of Clark National Forest would supply a basin need for an impoundment in a wilderness-type setting, with extensive adjoining public lands for wildlife recreation. A reservoir at West Fork Huzzah Creek site in the Huzzah Creek headwaters also would have these desired advantages. Moreover, it would satisfy sport fishing needs for residents in the southeastern portion of the Basin.
>
> "Finally, it would be desirable to provide a reservoir at the Upper Bourbeuse site in the northwestern corner of the Basin to increase fish and wildlife recreation opportunities for residents in that area.

d. Bureau of Outdoor Recreation and National Park Service. The Bureau of Outdoor Recreation and the National Park Service have submitted a joint report for the Meramec Basin Study, entitled "Recreation Needs as Related to Reservoir System Formulated." Their report includes recommendations for priority of construction for the Basin's recreational needs, the anticipated initial visitor-day attendance, and the initial development cost of the required recreational facilities. The National Park Service prepared the land development and operation and maintenance costs, based on attendance estimates made by the Bureau of Outdoor Recreation. The Bureau also prepared the recreational benefit estimates. The Bureau of Outdoor Recreation and the National Park Service have expressed the following views:

> ". . . It is our understanding that the Forest Service desires to plan and administer recreation on all reservoir associated lands within the National Forest. Administration by the Forest Service is logical and we recommend that such an arrangement be proposed in your report. Administration of recreation facilities by the Corps of Engineers within the National Forest, when the Forest Service, too, develops and administers recreation facilities, is unnecessary duplication. It is our feeling, also, that funds for recreation development on Forest associated reservoirs should be obtained under project authorization and appropriations."

e. Southwestern Power Administration. The Southwestern Power Administration in reviewing the hydroelectric power potential expressed the following views:

> "We feel that your office has thoroughly studied the possibilities of inclusion of hydropower in the comprehensive plan. However, based on data which you have supplied us there is no power plan in which the power costs of the project can be recovered by marketing power under the current marketing experience of this Administration. We forsee no radical changes in either the cost of hydroelectric power installation or the price of electric power that would cause the construction of power facilities to later be justified at the project studied."

9.2.1.4 Federal Power Commission.

The commission furnished pertinent power values, area-load duration curves, and reviewed all proposals for power. The Federal Power Commission expressed the following views:

> "Our power studies have shown that there is a potential power market for 10-percent (or less) plant-factor generating installations for 250,000 kilowatts at Salem, 400,000 kilowatts at Pine Ford, and 360,000 kilowatts at Meramec Park. Conventional economic analyses indicated that on a basis of specific power costs (which in the case

of Meramec River Basin projects are also separable costs) the B/C ratios for these three projects would range from 1.35 to about 1.50. Although we have not received information from your office as to the allocated joint costs which might be chargeable to power at these three projects, it in no event appears that the B/C ratios would be reduced to less than unity by consideration of these charges.

"Pursuant to the foregoing we recommend that you include in your comprehensive Basin report a presentation of the three hydroelectric projects suggested. We do not suggest that you recommend authorization of the construction of these projects; however, we believe the report should state that although presenting a favorable picture on the basis of conventional economic analyses, the power developments are not recommended for authorization by reason of the fact that the Southwestern Power Administration has stated they cannot dispose of the power output at the prices indicated.

"At the meeting in your office on October 15 it is understood the SPA representative stated that his Agency could obtain pumped storage power in Arkansas at lower costs than those indicated for the Meramec River Basin. It is likely that there are higher heads in Arkansas and that the unit cost for pump-back hydroelectric power there would be less than in the Meramec Basin. However, it is our view that Meramec Basin power would be integrated with electric power resources in the Illinois-Missouri power pool (SPA's 15 and 40), and possibly also with those in the Kansas City area. There is some question that projects in Arkansas could compete with Meramec Basin projects in this market area due to the likely greater transmission costs required to properly integrate these more remote plants with the electric power supply in the market area considered."

9.2.1.5 U. S. Department of Commerce - Area Redevelopment Administration.

The Area Redevelopment Administration assisted in developing data whereby project benefits from economic development in the area could be evaluated.

9.2.1.6 Missouri State Agencies.

a. Division of Geological Survey and Water Resources. The State Geologist actively assisted the Corps of Engineers in collecting and furnishing geological data and prepared a report on "Groundwater Use and Production Capabilities." This report also served the U.S. Public Health Service in evaluating the projected needs for water supply. The Division of Geological Survey and Water Resources expressed the following views:

"The Meramec River Basin Study as presented in the Oct. 15, 1963, meeting outlines an adequate and workable basin development program from the view point of the Missouri Geological Survey. Since the ground water and bedrock in the basin are our main concern, this endorsement is necessarily limited to these features. The selection of four intermediate and seven major sites for early consideration is certainly in line with the geologic suitability of these selected sites."

b. State Park Board. The Board cooperated with the National Park Service in determining recreation developments to be installed at various reservoirs under study. The following specific recommendations have been made by the Park Board.

"1. The Missouri State Park Board has no funds available at this time nor can the Board assure funds for recreational development from the State of Missouri for the non-federal contributions toward recreational benefits. Participation in non-federal contributions toward recreational benefits must depend upon appropriations from general revenue by the legislature.

"2. It is requested that the Missouri State Park Board receive an amount equal to the replacement costs for all buildings and facilities to be inundated at Meramec and Washington State Parks.

"3. It is requested that all inundated state park land be replaced with land above the conservation pool or similar level in fee title.

"4. It is requested that the water level on Meramec Park Reservoir be fairly constant.

"5. It is requested that the power distribution point for the Meramec Park Reservoir be located so that most of the power lines will not be on existing state park property. I understand this has been done at Norfork Reservoir. At the present time we have an approximate quarter mile wide power right-of-way across Table Rock State Park; we do not feel this is compatible with a state park.

"6. It is requested that consideration be given to withdrawing the policy of the Corps of Engineers of requiring an equal number of free campsites before a charge can be made on licensed areas.

"7. It is recommended that the joint land acquisition policy of the Corps of Engineers and Department of Interior as

now in effect be the guide for purchasing land.

***

"The above comments are in no way to mean that this department opposes the Meramec Basin Project."

c. Water Pollution Board. The Board undertook a stream survey in the Meramec Basin and collected field data with a portable laboratory. It has established 80 stations at which it is continuing to collect data which are being furnished to the Public Health Service. The Board held a public hearing on 22 July 1963 in Union, Missouri, regarding pollution in the Meramec River, at which time statements were presented by various federal agencies.

d. State Highway Commission. The Commission has reviewed the road relocations in the Basin plan and stated that its future improvements will be planned so as to minimize relocations due to reservoirs. The Highway Commission expressed the following views in regard to the main stream and tributary stream reservoir.

"As we were represented at the meeting in St. Louis on October 15, 1963, concerning the economic analysis of major and intermediate reservoirs considered in the Meramec River Basin Study and have reviewed the data presented at that time, this is to advise that we have no changes to recommend in the findings that were presented."

e. Conservation Commission. The Commission has assisted the U.S. Fish and Wildlife Service in coordinating that agency's responsibilities in connection with the current study of the Meramec River Basin. The Conservation Commission has presented the following views:

"The Missouri Conservation Commission now owns and manages 6,078 acres of land in its Huzzah wildlife area. Some 900 acres of this land will be inundated by Meramec Park Reservoir. The Missouri Conservation Commission has requested 4,400 acres be acquired and made available to that agency for the Huzzah wildlife area in mitigation for terrestrial habitat inundated by the proposed reservoir system for the Basin. The Governor's Advisory Committee on the resurvey of the Meramec Basin also recommends that all of the 4,400 acres requested by the Missouri Conservation Commission in mitigation for terrestrial habitat inundated by the reservoir system be acquired for addition to the Huzzah wildlife area. It is proposed to buy sufficient land to add to the Huzzah wildlife area to mitigate for the 900 acres inundated by the reservoir in that agency's holdings, plus an additional 600 acres. These lands would be acquired to block in Commission ownership between the Huzzah wildlife area and the reservoir. The Conservation Commission and the U. S. Fish and

Wildlife Service have indicated they will accept the remaining 2,900 acres within the boundaries of lands designated by the Bureau of Outdoor Recreation. These 2,900 acres would be for the primary purpose of wildlife management, i.e., adjacent to the Huzzah area and on the south side of the reservoir along the Meramec or Huzzah."

f. Division of Commerce and Industrial Development. The Division assisted in evaluating the economic impact of the proposed plan of improvement on the commerce and industry of the Basin.

g. Boat Commission. The management of water-based recreation in the reservoirs proposed for authorization will be fully coordinated with the Boat Commission.

h. University of Missouri Extension Service. The Extension Service is presently assisting local groups in organizing so that they may effectively support zoning, urban affairs, and allied concepts related to water resources development.

i. The Governor's Advisory Committee. The Governor appointed the Chairman of the Water Resources Board to act as Chairman of the Advisory Committee and to report to him the views of the State agencies having an interest in the report of the Corps of Engineers. The Governor's Advisory Committee expressed the following views:

"The following comments are made in regard to state and local participation in project costs and in regard to priorities for reservoir construction within the next 15 years.

"1. The committee is in agreement with the joint land acquisition policy of the Corps of Engineers and Department of Interior as now if effect. It is requested, however, that any deviations from this policy be submitted to the State of Missouri for approval or disapproval prior to the actual acquisition of land at an appropriate time.

"2. . . . It is the opinion of the Governor's Advisory Committee on the Resurvey of the Meramec Basin that provisions for future water supply storage should be included in the comprehensive plan for the development of water resources of the basin.

"3. At the present time there are no funds available to any of the Missouri State Agencies which can be used for the purpose of water supply storage in federal reservoirs. The Missouri Water Resources Board has been instructed by the Missouri legislature to investigate and to recommend a means whereby state and local obligations for water supply

storage can be met. A plan will be presented to the 73rd General Assembly which will meet in January, 1965. However, reaction of the legislature and future legislatures to the proposal of the Water Resources Board cannot be predicted and for this reason no assurance or the method of repayment can be made at this time.

"4. Apportionment of project costs also requires non-federal contribution toward recreational benefits. At present there are no funds available for recreational development from the State of Missouri for participation in meeting projects costs. The need for the recreational facilities proposed in the Corps of Engineers report is recognized. However, as with water supply storage no firm assurance for state or local participation can be made at his time. Future participation would be dependent upon appropriations from general funds by the legislature.

"5. Federal law provides for wildlife enhancement as a project purpose on a non-reimbursable basis, and the application of a policy of providing wildlife features on a non-reimbursable basis is recommended in the development of the Meramec Basin.

"6. The following reservoirs are recommended for authorization and construction within the next 15 years with the priorities designated in the following listing:

Priority No. 1	#29	Union
Priority No. 2	#17	Meramec Park
Priority No. 3	#9	Irondale
Priority No. 4	#27	Salem
Priority No. 5	#2A	Pine Ford
Priority No. 6	#1 38	Bourbeuse
Priority No. 7	#5	Washington Park
Priority No. 8	#40	Virginia Mines"

The following views represent the coordinated views of all of the State agencies:

"There is general feeling that headwater structures should not be included in the request for authorization for construction by the Corps of Engineers. This feeling is prompted by the confusion and possible harm to future soil conservation programs as a result of misunderstanding over the local participation requirements under the SCS program.

"Experience indicates that the small watershed development and the attractions of flood control impoundments associated with small watersheds are contributory to the acceptance by the farmers toward application of terracing, grassed waterways and retarding structures provided by each land owner. It is suggested, therefore, that your report recognize the possibilities of additional flood control and other beneficial uses associated with 'H' structures in a manner that will permit future development by soil and water districts and subdistricts established under the provisions of Missouri law.

"The above comments would, of course, only apply to those structures located on private lands outside the boundaries of the Clark National Forests. If the 'H' sites or intermediate sites within the boundaries of the Forests can be economically justified, there is no objection to including them as a part of the Corps of Engineers construction program provided state or local finiancial participation is not required.

"It is realized that the authorization document for the resurvey requires consideration of the Meramec Basin Corporation plan. If consideration must be given to including 'H' sites in your recommendations, it is requested that they be held to a minimum and that only 'H-6', 'H-13' and 'H-31' be retained."

9.2.1.7 Other Agencies.

a. St. Louis County Planning Commission. The St. Louis County Planning Commission has recommended for zoning as open space for recreational usage some 14,000 acres in the Meramec River floodplain. It has made the following statement with respect to the proposed plan of improvement:

"The St. Louis County Land Use Plan is based on projected needs of St. Louis County to the year 1980. The Corps of Engineers' planning is based on a 100-year analysis of need effective on a base year of 1970. The extreme difference in planning periods used by the two agencies results in the following: The Corps of Engineers' plan adds approximately 1,100 acres of residential use, 1,100 acres designated as urban use, and 1,800 acres as industrial use, all in the present floodplains of the Meramec River. These areas would not be beneficially affected by any upstream flood water storage capacity until the completion of the dams proposed on the Meramec River and its tributaries. It appears reasonable that it will take fifteen years to develop and effect the flood control system necessary to provide the degree of flood reduction in St. Louis County contemplated in current Corps of Engineers' studies. Therefore, the existing floodplain situation, in regard to the approximate

4,000 acres projected for urban use by the Corps of Engineers, will probably continue to 1978 in any case. At the time when flood protection becomes a reality, land use designations would be reconsidered in relationship to the needs for land for specific urban uses."

b. Meramec Basin Corporation. The Meramec Basin Corporation established cooperative committees to assist in coordination among federal, state, and local groups. These committees are currently investigating local participation requirements, including exploration of the need for conservancy districts and zoning requirements. The Meramec Basin Corporation has submitted the following statement with respect to the proposed plan of improvement.

"1. The Basin plan described in the U.S. Engineers' Synopsis of Findings of December 4, 1963, should be approved as the basis for the much needed program of long range care and development of water and related resources in the Meramec Basin.

"2. Action on the Basin plan should be phased for the immediate construction of at least 4 main stream reservoirs, 5 tributary stream reservoirs, and at least 5 headwater stream reservoirs.

"3. At the earliest possible date there should be developed those angler use sites that fit into the pattern of reservoirs chosen for initial construction.

"4. The levee system, and related features proposed, should be installed as soon as arrangements with local interests can be completed.

"5. In meeting the increasing demands of a growing population through the Basin plan, the detailed planning for actual development should give special attention to all possible insurance of the preservation and proper use of natural resources and unique scenic and man-made attractions.

"6. In the progress of the detailed planning for actual development, particular care should be exercised to safeguard the rights, and lessen the problems of landowners and others affected by reservoirs, levees, and other proposed facilities.

"7. Continued and close cooperation between government agencies and people of the Basin should be maintained in light of the variety of responsibilities and participation that is implicit in the Basin plan with the interests involved of federal, state, and local government, local organizations, the public generally, and many individuals.

"8. The well being of the people of the Basin, the progress of its economy, and the proper care of its natural resources call for immediate and urgent action on the above recommendations."

c. Mississippi Valley Association. Representatives of the Mississippi Valley Association have attended the coordination meetings and have expressed approval of the basin plan.

9.2.2 POST AUTHORIZATION COORDINATION

During detailed project planning, interested federal, state, and local agencies cooperated in planning efforts. This coordination was maintained by correspondence, field trips, and telephone communication. The following agencies cooperated in the planning effort during this period:

U. S. Forest Service
U. S. Soil Conservation Service
Federal Water Pollution Control Administration
U. S. Bureau of Mines
National Park Service
U. S. Bureau of Outdoor Recreation
U. S. Geological Survey
U. S. Economic Development Administration
U. S. Public Health Service
U. S. Bureau of Sport Fisheries and Wildlife
Missouri Water Resources Board
Missouri State Park Board
Missouri Water Pollution Board
University of Missouri
Governor's Cooperative Planning Committee
Missouri Department of Conservation
Missouri Division of Commerce and Industrial Development
Missouri Boat Commission
Missouri State Highway Department
Missouri State Geologist
Missouri Department of Agriculture
Missouri State Interagency for Outdoor Recreation
Meramec Basin Association

9.2.3 COMMENTS REQUESTED BUT NOT RECEIVED

The draft Environmental Impact Statement was sent to the following agencies or organization, but no comments were received:

U. S. Department of Health, Education and Welfare, Regional Director
U. S. Department of Transportation, U. S. Coast Guard
Clark National Forest, Forest Supervisor
U. S. Forest Service, Regional Forester
U. S. Department of Commerce, NOAA
Mayor of Sullivan, Missouri
Mayor of Union, Missouri
Mayor of Steelville, Missouri
Mayor of Bourbon, Missouri
Mayor of St. Louis, Missouri
Supervisor of St. Louis County, Missouri
Mayor of Eureka, Missouri
Mayor of Pacific, Missouri
Mayor of Fenton, Missouri
Mayor of Valley Park, Missouri
Mayor of Cuba, Missouri
Institute of Environmental Studies
St. Louis Audubon Society
Webster Groves Nature Study Society
Chamber of Commerce of Metropolitan St. Louis
St. Louis County Department of Planning
East-West Gateway Coordinating Council
Meramec Regional Planning Commission
The Coalition of American Rivers
Missouri Botanical Gardens
Coalition for the Environment
Environmental Defense Fund
The Wildlife Society, Missouri Chapter
The Nature Conservancy, Missouri Chapter
Conservation Federation of Missouri
Audubon Society of Missouri
Environmental Response

9.2.4 COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The following are comments received from Congressional representatives and federal and state government agencies. Following each comment is the response.

9.2.4.1 U. S. SENATOR THOMAS F. EAGLETON (letter dated 5 March 1974)

Comment 1: Thank you for sending me a copy of the Draft Environmental Impact Statement for Union Lake, Bourbeuse River, Missouri. I found it to be quite interesting and I know my staff will find it to be helpful.

Response: Comment noted.

9.2.4.2 U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY (letter dated 28 March 1974)

Comment 1: [illegible] the Alternatives, and must take the form of a [illegible] the relationship of the proposed action and the alternatives [illegible] "The Meramec River Comprehensive Basin Study." The paragraph [illegible] under that heading appears to differentiate between the [illegible] the "framework plan" and of the "study." The paragraph states that "[illegible] agreement was reached as to a framework plan, [illegible] treatment of agricultural lands and forest improvement [illegible] multiple-purpose storage reservoirs on the main stem [illegible] levees or flood plain regulations in the lower [illegible] of the study that these needs (flood control, [illegible], water quality control, fish and wildlife [illegible] fully satisfied by a series of mainstem, headwater and tributary reservoirs, and several levee projects." These two sentences do not seem to us to be consistent. One states that a comprehensive approach to the Basin's problems, incorporating both structural and non-structural [illegible] agreed upon, while the second states that the study found that [illegible] could be satisfied by structural measures alone.

Response: The term "framework plan" applies to the format of the plan of the proposed study of the Meramec Basin. It was not intended to describe how the Basin needs would be met before the needs were determined. As the study progressed the needs were identified. These needs were flood control, recreation, domestic, municipal, and industrial water quality control, fish and wildlife conservation and area redevelopment. After identification of the needs further investigation and evaluation led to the conclusion that the needs could best be met by mainstream, headwater and tributary reservoirs and local protection levee projects.

The five authorized projects provide a practical alternative which approaches satisfaction of the Meramec Basin needs. Undoubtedly other non-structural measures and alternatives such as future watershed treatment of agriculture lands and forest improvements in the upper basin will be important in alleviating the storage shortfall in the authorized projects.

Comment 2: Moreover, where the Draft discusses nonstructural flood damage protection measures, and combinations of such measures with structural measures as alternatives considered, it does not include "watershed treatment and forest improvement in the upper Basin" among the nonstructural measures. We realize that in considering and discussing alternatives, you cannot discuss every possible combination, but one alternative which we think should be included is the comprehensive approach envisioned in river basin studies.

Response: See response to Comment 1 above. This alternative was not discussed because it failed to meet such needs as water supply, flat water recreation, and flood control in the lower urbanized areas. This alternative is also unenforceable on non-federal lands in the basin.

Comment 3: XII. PLANS OF OTHER FEDERAL AND STATE AGENCIES (page One-22) states that Lake I-26 on the West Fork of the Huzzah is in the detailed planning stage. This site has proved to be unfeasible and a new site has been located. The I-26 project has been replaced by a site on Barney Fork, a tributary of the West Fork of the Huzzah, and has been designated as the Barney Fork Project.

Response: Concur. This change has been made in the final environmental impact statement in paragraph 1.12.1.

Comment 4: We note that 12,733 acres of "brush and timber" will be acquired in fee for the project, with easements on an additional 374 acres, a total of 13,107 according to page One-14. Part Seven states that 4,417 acres will be inundated at normal pool, with preservation of most of the remaining 9,002 acres, a total of 13,419. This may indicate some need for reconciliation of data. About 1,494 acres of land will be subject to inundation about every two years, and an additional 735 acres every five years; we don't know how much of these areas are forested, but a problem of death of trees due to inundation usually develops.

Response: Concur. The PART EIGHT of the final environmental impact statement has been changed to reflect the correct figures.

In regards to possible flooding and killing of trees, all feasible alternative clearing combinations will be considered and coordinated with the appropriate agencies to assure a satisfactory balance between esthetic value, fish and wildlife habitat, boating safety, water quality and public health.

Comment 5: In Section II BIOLOGICAL ELEMENTS, the final sentence of (3) Site-type III (Slopes) refers to oaks, hickories, maples and other species as "dominant understory species." Oaks and hickories (and possibly maples) are the dominant overstory genera, and the others named are understory species. (When we tried to check this statement against the Technical Appendix, we found only the oaks and hickories referred to, so the basis for the statement apparently is elsewhere.

Response: Overstory species associated with this site type are oaks, hickories, ash, persimmon, red cedar and occasional sugar maple. Understory species include dogwoods, redbud, crabapples, serviceberry, sumacs and buckthorn. They were omitted in the draft environmental impact statement due to a typing error. The final environmental impact statement has been corrected (paragraph 2.2.1.2.)

Comment 6: Except for our major comment above, we feel that the Draft does a good job of meeting NEPA requirements. We think that the discussion of IMPACT ON TERRESTRIAL ORGANISMS DOWNSTREAM OF THE RESERVOIR is particularly good.

Response: Comment noted.

9.2.4.3 U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE (letter dated 2 April 1974)

Comment 1: Table 9 is supposed to show the percentage of soil types in the basin, but it does not have this information included.

Response: The reference to PART ONE, Table 9 of the Technical Appendix which said that the percentage of soil types was presented was in error. It is felt that the compilation of this data would not be necessary in the Bourbeuse Basin because the surficial soils consist mostly of Lebanon and Union silt lands in approximately a one to one ratio.

9.2.4.4 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (letter dated 16 April 1974)

Comment 1: The environmental protection provisions mentioned in the impact of construction, (Three-1) should be explained in greater detail. Specifically, more information should be provided on method(s) of preventing fugitive emissions of smoke and particulate material associated with waste disposal and construction practices. Applicable regulations should be cited.

Response: Environmental protective guidelines are set forth in Corps of Engineers booklet CE-1300 dated June 1973. The final environmental impact statement has been changed to include these changes (paragraph 4.1.1).

Comment 2: The methods of disposal of clearing spoil such as trees, roots, etc. should be identified. We believe burning should be considered only after disposal by other methods has been fully investigated and determined unacceptable or infeasible. Burning should be coordinated with state and local governments to ensure that burning will not be in violation of state or local regulations. If disposal by burning is adopted a method such as forced air open-pit burning should be used to reduce particulate emissions to the atmosphere.

Response: The method of disposal of trees is discussed in PART ONE, (1.5.2) and PART FOUR (4.1.1) of the environmental impact statement.

Comment 3: Traffic volumes should be projected for the proposed recreational areas to permit an assessment of potential air quality levels.

Response: At the present time the E.P.A. records that a total of hydrocarbons, carbon monoxide, and nitrous oxide equal 66.7 pollutant grams per mile from automotive transmissions. When the project is operational in 1980 national pollution standard will reduce auto emissions pollutants to 28.5 grams/mile. When the recreation facilities are fully operational approximately 536,000 cars will visit the site per year. Peak day traffic will be approximately 18,000 cars. This is in addition to existing traffic.

In as much as urban development of this area is not at present foreseeable, the traffic quantities are not known. We have no way of calculating the traffic induced pollution without the project. PART FOUR (4.3.7) of the final environmental impact statement has been changed to include the traffic estimations.

Comment 4: Predicted volumes of recreation vehicles associated with recreational areas, the lake and surrounding project area should be included. This information is pertinent for noise analysis in sensitive areas both in and around the present and future Union Lake park areas. Noise levels associated with construction should be included to assess potential noise related impacts in the Bourbeuse River Basin, and specifically, the Union Lake Area.

Response: Estimated volumes of traffic are given for Comment 3. Increase of traffic and use will increase noise levels. This office knows of no existing noise data and has no means to do the required monitoring.

It is estimated that the maximum overall sound pressure (SPL) associated with construction of Union Lake will be 65 dB at a structure 0.25 miles away (the site of the nearest residence). The environmental impact statement (4.1.1) has been changed to add this information.

The SPL of rural areas is typically 40 dB during the day, and 30 dB at night. Thus, the construction would cause a noticeable change to the ambient conditions. It will not, however, cause the SPL of the area to be intolerable or of nuisance value. The overall SPL of a business office is typically 60 dB, and the overall SPL of average street traffic is typically 70 dB.

Construction of the entire Union Lake project is expected to take 6 years. Construction of the dam itself will take approximately 3 years. Work is scheduled to be performed in a normal workday shift; 0800 to 1700 hours, five days per week. No overtime or weekend work is planned, but such work may be necessary.

Comment 5: In order to assess the future water quality of the lake, soils and vegetation should be investigated to determine the amount of organics present in the soil. From this assessment the amounts of leachable color, nutrients, organic acids and change in pH should be determined. Additional analysis can provide an indication of inorganic salts which may increase the total dissolved solids in the lake. These aspects should be included in the final environmental impact statement.

Response: We concur with above comment. The soils and vegetation as well as the stream bed material are important in assessing the water quality. Preimpoundment water quality investigation will include soil and bed material analyses. Availability of funding will govern the scope of work and time frame.

Comment 6: In reference to water quality parameters in the Union Lake Area; values of ammonia were recorded as 0.25-0.55 mg/l (P-110). An explanation of these values should be included particularly what parameters are actually being measured and what effect the potential alkaline conditions will have on the release of free ammonia. This information is essential in permitting an assessment of potential water quality in Union Lake for aquatic life and water supply.

Response: Water quality data is minimal in the entire Meramec River Basin, including the Bourbeuse River. Data listed is a compilation of individual studies performed by various agencies over several years. A detailed water quality investigation study of the Bourbeuse River is required to assess the potential water quality in Union Lake. The St. Louis District, Corps of Engineers, will begin a detailed water quality study during the summer of 1974 to obtain data required to fully assess the water quality.

Comment 7: It is stated on Page P-40 that domestic water related problems may affect public health. This should be explained in greater detail. Coupled with the potential feedlot runoff this would increase the potential of possible public health problems within the project area. This potential should be documented along with information as to control and/or abatement of such hazards.

Response: Most rural areas have problems in treating the domestic waste to a degree that insures a healthy environment. Locations and size of towns will not create an immediate danger to the lake. Upgrading of sewage treatment plants and educating those individuals responsible is the major means of improving the domestic waste problem. Animal feedlot runoff is a serious problem in that non-point pollution sources are difficult to rectify due to their widespread locations. A complete inventory of all feedlots will be obtained through field survey teams. Each feedlot will be evaluated as to its pollution potential. Possible remedial measures include retention ponds with partial treatment and regional wastewater treatment.

Comment 8: The statement, "Industrial discharge does not seem to be of significant pollution potential," should be expanded. Industrial discharge points should be identified for potential influx into Union Lake. These discharge points may have potential water quality related problems because of industrial expansion. Therefore a recognition of these possible sources of water quality degradation should be included in the final statement.

Response: A complete listing of all industrial discharge points is found in Environmental Inventory of the Meramec Basin, Ryckman, Edgerley, Tomlinson and Associates, 1973. This listing indicates only one State permit for industrial discharge into the Bourbeuse River, a clay pit drainage process in Franklin Co.

Comment 9: The statement should also idenfity the location, type and degree of treatment, and discharge for waste treatment facilities and the methods of disposal of solid wastes particularly in recreation areas.

Response: A complete listing of all waste treatment plants with detailed information is included in report referenced in response to Environmental Protection Agency Comment 8 above.

It is impossible to state with certainty which areas will have waterborne sewage. This decision will be made when the Master Plan is prepared and the funds are allotted for each area. The statement can be made that where there is waterborne sewage a treatment system will be provided which meets the approval of the Missouri Clean Water Commission and the Federal Environmental Protection Agency. This system will either be a mechanical system

capable of providing tertiary treatment of an average of 4 BOD and 5 SS or a land treatment system providing a tertiary treatment.

Solid waste collected from the project will be transported to a state approved sanitary landfill for disposal. Receipts will be collected from the hauler to insure that the waste was delivered to the landfill before the hauler is paid. The hauler will be required to furnish inclosed packer trucks.

Comment 10: Under our present policy, we cannot approve the allocation of storage for water quality control in Union Lake. Section 102(b)(3) of the Federal Water Pollution Control Act Amendments of 1972 states in part, "The need for, the value of, and the impact of, storage for water quality control shall be determined by the Administrator..."

Response: It is recognized and stated on page ONE-24 (paragraph 1.13 in the final EIS) of the draft Environmental Statement that Section 102(b) of the 1972 Amendments (PL 92-500) apply to Union Lake. The storage disallowed for maintenance of water quality will be assigned to other project purposes. Table 6 (PART ONE) of the statement indicates the Union Lake project has a viable benefit cost ratio with the deletion of streamflow augmentation benefits.

Comment 11: Waste discharges below Union Lake project should be sufficiently treated at the source to maintain water quality as indicated in the water quality standard, Meramec River and Tributaries, Missouri Water Pollution Board, June 1968.

Response: Concur.

Comment 12: Reference was made to the downstream enhancement of wildlife and related stream organisms due to controlled stream flow. It should be stated that the stream fluctuations associated with the Bourbeuse River are natural to the existing environment, in that the aquatic organisms are adapted to the seasonal fluctuations of the river flow. It should also state that with this project these fluctuations will be eliminated.

Response: The impacts of decreased stream fluctuations downstream from Union Lake has been discussed in PART FOUR of the environmental impact statement (paragraph 4.1.12). It is noted that these fluctuations will be reduced but not eliminated.

Comment 13: The information on water supply attributed to the Union Lake project should include additional information on future users. Specifically, it should identify which municipalities above the dam are potential users of water supply storage.

Response: On 21 November 1969 the State of Missouri acting by and through the Missouri Water Resources Board tendered to the Federal Government a document titled "Assurances on Water Supply, Union Reservoir, Bourbeuse River, Missouri." Under this instrument the State of Missouri agreed to pay the project first cost allocated to water supply which was as of 1 July 1969, $3,900,000. This was estimated to be $15,300 and the annual replacement costs were estimated to be $1,800. The State requested the Corps

of Engineers to provide in the project [illegible] acre-feet of water supply storage to meet the anticipated need during the project life. It was estimated that the [illegible] yield would be a mean daily flow of 71,000,000 gallons at the reservoir site.

Pursuant to this document of assurance the block of water supply storage would be under the ownership and jurisdiction of the State of Missouri. The State would be free to sell the water to private parties or public agencies having a need therefor. The future water districts will be formed and the existing towns of Union, St. Clair, Stanton, Beaufort, and [illegible] for the water.

Comment [illegible] on planning and zoning of the surrounding [illegible] indicates that growth around the project area will [illegible]. The major concern is with non-project areas which are the responsibility of local governments. The growth of the area will [illegible] with or without the project, however, an accelerated situation will [illegible] the project is approved. We suggest that non-project area [illegible] basin be implemented prior to project approval.

Response: [illegible] Union Lake project was approved and authorized by the decision [illegible] Congress, in the Flood Control Act of 1938. As stated, [illegible] planning and zoning ordinances is a local responsibility. [illegible] suggested that a total planned region, including plans for highways, residential, commercial and industrial occupancy, recreational facilities and water and related land resources, should be prepared. In theory this would be desirable. However, due to fragmented responsibility among Federal, State and local agencies, lack of funding and enabling legislation, this suggestion is impractical.

Franklin County, Missouri, the host county for Union Lake, is probably one of the [illegible] equipped counties in the State of Missouri to accept the [illegible] of a multi-purpose water resource project. Franklin County has had a Master Plan prepared by its consultant, Harland Bartholomew and Associates. The County has enacted county-wide planning ordinances and a [illegible] building code.

Comment [illegible] zoning is also necessary to control waste treatment systems at commercial facilities and residential developments around the lake. [illegible] septic tanks and private waste treatment systems are often poorly operated [illegible] could result in extensive water quality problems in the lake.

Response: Concur. The enforcement of water anti-pollution laws is under the jurisdiction [illegible] the Missouri Clean Water Commission.

Comment [illegible]: We appreciate this opportunity to review and comment on the draft environmental impact statement. Please forward a copy of the final environmental impact statement to us with review comments when it is sent to the Council on Environmental Quality.

Response [illegible]: Comment noted.

[illegible] FEDERAL POWER COMMISSION (letter dated 8 March 1974)

Comment 1: This is in reply to your letter of February 25, 1974, addressed to the Commission's Advisor on Environmental Quality, requesting comments of the Federal Power Commission on a draft environmental statement for Union Lake, Bourbeuse River, Missouri.

Response: Comment noted.

Comment 2: The Union Lake project was authorized by the Flood Control Act of [illegible] and modified by the Flood Control Act of 1966 which incorporated the project into an overall plan for development of the Meramec River Basin.

Response: Concur.

Comment 3: These comments of the Federal Power Commission's Bureau of Power are made in accordance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality. Our principal concern with developments affecting land and water resources is the possible effect of such developments on bulk electric power facilities, including potential hydroelectric developments, and on natural gas pipeline facilities.

Response: Comment noted.

Comment 4: The Commission has previously considered the hydroelectric power potential of the Union Lake project. In its letter to the Chief of Engineers, dated May 27, 1966, reviewing the comprehensive plan for the development of the Meramec River Basin, the Commission concluded that there was no opportunity for economical hydroelectric power development at this project.

Response: Concur. Hydroelectric power development is not a project purpose for Union Lake.

Comment 5: The draft environmental statement indicates that project construction will involve remedial measures to existing power lines, presumably relocation or protection. Such measures should be undertaken in such a manner as to minimize any disruptions of service.

Response: Concur. Efforts will be made to minimize any disruptions in service.

Comment 6: The draft review indicates that construction of the Union Lake project would not affect any electric power or natural gas pipeline facilities under the jurisdiction of the Federal Power Commission. Also, the project would not appear to have any significant effect on the development of future supplies and transmission of electric power or natural gas

Response: Comment noted.

9.2.1.6 DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, REGION VII
(Letter dated 4 March 1974)

Comment 1: We have received the Draft Environmental Impact Statement prepared by your office for the Union Lake, Bourbeuse River, Missouri project.

Environmental reviews for projects in the eastern portion of Missouri are made by our St. Louis Area Office. We are forwarding your draft statement to Mr. Elmo Turner, Area Office Director, who will submit his comments directly to you.

Response: Comment noted.

9.2.1.7 DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, AREA OFFICE
(letter dated 22 April 1974)

Comment 1: Our primary concern is that the environmental statement does not include a detailed analysis of the additional reservoirs and basin developments which are required to support this proposed project. Collectively, the proposed major reservoirs in the Meramec River Basin will have a [illegible] environmental impact on the St. Louis Metropolitan Area as well as the regional land use and transportation plans. Therefore, it is suggested that a cumulative comprehensive environmental statement for all proposed developments within the basin should be prepared. Due to the energy shortage and changing economic conditions, it is most difficult to intelligently analyze and review a major river project proposal, especially within a S.M.S.A., without evaluating all aspects of a river basin development program.

Response. The Comprehensive Study of the Meramec Basin and the Plan recommended for development of the basin in the Summary Report (June 1965) contemplated that the principal reservoirs would act as a system. However, it will be noted from detailed consideration of the report, that although related, each of the impoundments can be constructed without the others. Each lake would meet a proportionate part of the basin needs and develop its respective project benefits which make it economically feasible. All the reservoirs acting together would approach total satisfaction of the basin needs. The construction of a particular lake will have its individual impact on the environment. As the phased construction proceeds, each reservoir's impacts will be determined at that particular point in time. As an example, an Environmental Impact Statement has been prepared to Congressional Appropriations to initiate construction. To endeavor to forecast the total impact of all construction which will probably cover a 20- to 25-year period, would be conjectural and would undoubtedly require many revisions. This would especially be true, if the location, size, or purposes of an impoundment changed, as a result of the detailed design required prior to Congressional Appropriations to initiate construction.

By review of House Document 525, page 6 which was made part of Public Law 89-789 by reference, it will be noted that "Under the District Engineer's plan, local interests would be required to repay the United States for all costs allocated to water supply, in accordance with provisions of the Water Supply Act of 1958 and the Federal Water Pollution Control Act

Amendments of 1961 . . . they would also be required to pay their part of the construction cost allocated to recreation in accordance with the cost-sharing policies outlined in the Federal Water Project Recreation Act (Public Law 89-72)". The "local assurance" requirement, cited as a precedent to construction in H.D. 525, in effect gives the local interest (in this case the State of Missouri) veto power over the construction of any reservoir. This possibility negates the contention that the projects in the plan for development of the Meramec Basin must be constructed on an all or none basis.

Comment 2: We are also concerned about the increased rate of development in this rural area if the project is approved. A recent field reconnaissance of the site revealed increasing scattered development activities. In addition, numerous real estate signs advertising lots and home sites were observed. Unless a comprehensive plan is prepared for land outside the project areas which provides policies and procedures for implementation, and which is based on land use goals and objectives of the region and the county, then desired project objectives probably will not be achieved, and the process of guiding development adjacent to the largest federal project in Franklin County will produce unwanted effects and frustrations for everyone.

Response: See response to Environmental Protection Agency Comment 14.

Comment 3: It should be noted that both land use controls and planning of nonproject lands are local matters, governed by the citizens whose interest they concern. Even if a comprehensive plan is developed and adopted by the local legislative authorities, a major consideration is that Franklin County and the incorporated communities have all the essential tools and procedures to effectively implement the plan. In theory, zoning ordinances and building codes are supposed to implement plans, but experience reveals that, in practice, they seldom do; other procedures are usually required.

Response: Concur.

Comment 4: It is suggested that existing and proposed county and municipal land use plans, control proposals, and implementation procedures, be jointly reviewed with the Corps, the East-West Gateway Coordinating Countil, and the Missouri Department of Community Affairs. This could lead to a more uniform and comprehensive planning and development process. Land use control proposals adjacent to the project area should be based on carefully conceived objectives which include input from the local residents, developers, and officials. These goals have to be the heart of the comprehensive plan. Another factor which must be emphasized is the importance of local and regional citizen involvement in the land use planning and control process. Citizen concern has been most evident at the local level throughout the St. Louis Metropolitan Area, especially in the rural areas. In many localities, they are demanding a slowdown in the growth process. Initially, people are demanding that public officials conserve natural resources and protect the environment. The citizens must be informed about the direction and substance of the project impact (physically, socially, economic) and a channel for citizen input into the planning process must also be provided.

Response: See response to EPA Comment 14. As stated, the Corps has no authority to control land use beyond the boundaries of the project land.

It has been the policy of the Corps to encourage, during all states of planning, construction, and operation of water-resource projects such as Union Lake, the adoption of comprehensive regional planning and zoning. This has been done at Lake Shelbyville, an impoundment in Central Illinois. As a part of a cooperative effort, a committee was established consisting of County, State, and Corps representatives. The objective of this body was to achieve regional planning for lands within and outside the project boundaries. Planning and zoning has been adopted by one of the concerned counties with progress being made to that end in the remaining county.

Comment 5: The statement should further emphasize that during this past year, land use proposals have been introduced by Congress and extensive hearings were held. There is still extensive congressional review and the land use issue is very much alive. Those jurisdictions who ignore these emerging needs for a new system of land controls run the risk of having decisions imposed upon them at a level higher than their own. Therefore, the development and adoption of land use plans and controls most appropriate to carry out the intent of the proposed project and especially the enforcement of the application upon lands in private ownership through the regulatory power of the local county or municipality must be discussed and encouraged.

Response: See response to Housing and Urban Development Comment 4 and Environmental Protection Agency Comment 14.

9.2.4.8 U. S. DEPARTMENT OF THE INTERIOR, OFFICE OF THE SECRETARY (letter dated 18 June 1974)

Comment 1: A thorough survey is necessary to adequately define the impact on cultural resources as the draft statement does not contain an adequate discussion. It acknowledges that two sites are under consideration for nomination to the National Register of Historic Places, but it does not reflect compliance with Section 106, P.L. 89-665 and Sections 1 (3) and 2 (6) of E.O. 11593. This is particularly essential in that these two sites, Noser's Mill and the Koenig Site, have been referred to the Secretary of Interior for determination of eligibility for nomination. Until a complete survey and inventory of the project area is made, a comprehensive plan of salvage cannot be developed.

Response: The St. Louis District has had an historic survey of the project area by a professional historian; the results have been added to the final EIS (paragraphs 2.3.4 and 4.3.6). As discussed in these paragraphs of the final EIS, Noser's Mill has been determined to be eligible for the National Register of Historic Places, and this District plans to comply fully with Section 106, P.L. 89-665 and Sections 1(3) and 2(6) of E.O. 11593. No determination has been made as to the eligibility of the Koenig site; however, if this site is determined eligible, the St. Louis District will comply fully with the above-mentioned laws contracted and the St. Louis District has also received a report by a professional archeologist evaluating the adequacy of the available archeological information. This study reveals that two more years will be needed to make a reconnaissance of the project area and perform necessary salvage operations. The St. Louis District will fund this work. (See paragraph 4.3.5 of the final EIS).

Comment 2: We are pleased to see the reference to the 1962 "acquisition policy" agreement between the Departments of Army and Interior. However, the statement does not explain how this policy will be implemented with respect either to the acquisition and/or subordination of mineral interests. Nor does it indicate that before an easement can be taken in lieu of fee title the lands must be examined by the Bureau of Sport Fisheries and Wildlife and the Missouri Department of Conservation to determine their significance for protection or enhancement of fish and wildlife resources.

Response: The 1962 "acquisition policy" will be implemented with respect to the acquisition and/or subordination of minerals by a strict interpretation i.e., generally, fee title to all subsurface interests will be acquired in areas required for all structures, are required for project operations and public use, including access, and in areas where the value of mineral interests is nominal. The reservation of mineral rights, where development will not interfere with project purposes, will be predicated upon the Government's right to regulate their development as to eliminate any interference with project purposes and to minimize any adverse impact on the environment, including esthetic values.

Coordination was conducted with the Bureau of Sport Fisheries and Wildlife and the State of Missouri Department of Conservation during the planning processes. Certain areas in the upper reaches of Union Lake that were originally requested by the Department of Conservation, have been proposed, subject to approval, for management by the Department of Conservation under the "General Plan and Cooperative Agreement".

Comment 3: The statement does not consider the possibility of pollution from the filled zinc-iron mines listed on page 60. If any of these mines would be inundated, the statement should describe mitigating measures.

Response: None of the zinc-iron mines listed on page 60 will be inundated by the lake. Pollution from these mines will subsequently be no problem.

Comment 4: The need for recreational areas for the people of St. Louis is recognized, but conditions have changed considerably since these reservoirs were authorized. Alternatives are now available. Development of the Great Rivers Recreation Area in the immediate vicinity of St. Louis would help to satisfy this demand, save gasoline, and provide the opportunity for many unable to travel as far as Union Lake.

Response: The proposed Great Rivers Recreational Area on the lower Meramec is a proposal with great recreational potential for the St. Louis area. Although the metropolitan area expressed strong interest in this proposal, support from other areas and agencies has not been forth coming at the present time.

Available information indicates that this project has been recommended for restudy, and that as yet such study has not been provided for.

Comment 5: The construction of Union Dam and Lake will have a deleterious impact on fish and wildlife resources. The Bureau of Sport Fisheries and Wildlife on January 28, 1964, provided a Preliminary Report on the effects of the water development plans for the Meramec River Basin. In this report, the Bureau stated that additional investigations would be conducted when more detailed plans became available. The Bureau, however, has not updated the 1964 Report.

We believe a 10-year lapse of time allows for considerable social, legislative, and biological changes to occur; therefore, the previous report is no longer valid. Until new studies are completed and loss compensation and enhancement features identified and evaluated, a true appraisal of the environmental impact cannot be made.

Response: Your statement concerning the lack of fish and wildlife studies since 1964 is not considered correct. Budget justification data provided by the Bureau to support the Chief of Engineers request for Construction General funds for transfer to the Bureau indicate that since fiscal year 1967 some $46,600 has been requested for fish and wildlife studies in the Meramec Basin project. Funds have been transferred to the Bureau each year for these fish and wildlife studies.

Comment 6: Based on the comments contained in this letter, the Department of the Interior believes that an adequate Union Lake Environmental Impact Statement must fully recognize and answer the specific comments contained in this letter. We believe that these issues warrant full coverage in the Impact Statement.

Response: Concur. The St. Louis District will make every attempt to satisfactorily answer these questions.

Comment 7: Page One - 8. Spillway discharges will be to a natural ravine that returns to Voss Creek, and then to the Bourbeuse River at Reiker Ford. Maximum spillway discharges are identified at 85,700 c.f.s.; however, no mention is made in the EIS of any impacts on Voss Creek or the ravine should it be necessary to use the spillway.

Response: Concur. The final EIS has been changed to incorporate this comment in the impact on streams in paragraph 4.1.11.

Comment 8: Page One - 8. The Bureau of Sport Fisheries and Wildlife has no intention of constructing a fish hatchery below the dam and the statement should be corrected.

Response: Comment noted. The discussions pertaining to the construction and operational commitments in reference to a fish hatchery have been reworded to clarify the Bureau of Sport Fisheries and Wildlife's portion.

Comment 9: Page One - 14. The statement indicates that flowage easements are to be acquired on 1,892 acres of land. To fulfill the joint land acquisition policy of the Departments of the Interior and Army, these lands would have to be examined by the Bureau of Sport Fisheries and Wildlife and Missouri Department of Conservation to determine the significance for protection or enhancement of fish and wildlife resources.

Response: The St. Louis District would be pleased to coordinate possibilities for fish and wildlife enhancement with the Bureau of Sport Fisheries and Wildlife and the Missouri Department of Conservation.

Comment 10: Page One - 14. The statement should indicate whether the 21,993 acres to be acquired in fee would include mineral acquisition or subordination. If the "Joint Policy of the Departments of Interior and Army Relative to Project Lands" is followed, mineral interests would be acquired only where mineral development would interfere with primary project purposes.

Response: See response to Comment 2.

Comment 11: Page One - 19. We wonder how the values for fish and wildlife benefits were determined. Our knowledge of the project indicates that it will have adverse effects on fish and wildlife habitat. Until these effects are evaluated and mitigation measures for the losses incorporated into the development plan, we seriously question the benefits claimed for fish and wildlife in the statement.

Response: The benefits assigned to fish and wildlife were prepared by the Fish and Wildlife Service, U. S. Department of Interior, in a report dated 28 January 1964. This information was published by this office in the Meramec Comprehensive Basin Study, Volume 7, Appendix O.

The Fish and Wildlife Service did not detail their methodology for their figures; however, the figures do include the necessity for mitigation land and these lands are a part of the project.

Comment 12: It is impossible to assign negative benefits until the fish and wildlife losses are evaluated, mitigation measures developed, and the amount of uncompensated losses determined.

Response: Please refer to the response for Comment 11.

Comment 13: Page One - 15. "Once the lake is filled to the top of the joint-use pool, releases will approximate inflows except during floods and droughts." This expected downstream flows during flood conditions was adequately described; however, some idea of what type of flows which could be expected during time of drought should also be given. Also needed is some idea of releases expected during initial filling of the lake.

Response: A minimum daily release of 11 c.f.s., as shown in Table 2, SECTION ONE, will be made whenever the reservoir level is below the top of the joint-use pool. This includes the period while the reservoir is being filled.

Comment 14: Page One - 16. "The control of floods by the impoundment will increase the number of days on which float trips are possible, stabilize the banks, and improve channel conditions." However, on page One - 15, it states that flows at or above three-quarters bankfull will increase from 15 days per year without the dam to 40 days per year with the dam. Such flows will cause bank cutting. We do not see how increasing these flows will stabilize the banks and improve channel conditions.

Response: The reduction in river stage fluctuations could help stabilize the banks by preventing the failure of saturated banks during rapid decrease in stage. However, it should be noted that the bank could be subject to erosion during the higher stages if excessive velocities are present.

We did not intend to imply that the banks of the river below the dam would become stabilized in its present location, but will adjust with time until it tends to become stable for a 4,000 c.f.s. maximum flow. Our reference to improved channel conditions refers to flow conditions in the channel, i.e., more water available within banks on which recreational activities can take place.

Comment 15: Page One - 18. The net increase of 250,690 fisherman-days annually with the project are contingent upon necessary loss compensation measures being implemented. Reexamination of the area and identification of such measures are necessary before this value can be established.

Response: Mitigatory measures have been discussed with representatives of the Missouri Department of Conservation and are discussed in Missouri Comment 3. In addition, as part of the basin plan, 19 angler use sites will be developed. They are shown on PLATE 1 in SECTION ONE of the EIS.

Comment 16: Page One - 19. Are flood control benefits for only presently existing development in the flood plain, or do they include benefits assignable to future development which will be encouraged by completion of the projects? It is the view of the National Water Commission that the major problem of reducing damages to existing development is overshadowed by the need for keeping additional exposure to flood damages from developing. Flood damages are increasing in spite of billions of dollars spent for protective works. In view of the statement made by the St. Louis County planning commission on page eight - 22, it would appear that some benefits assignable to flood control are for expected future development encouraged by the project. Since construction will not provide for protection from Mississippi River backwater, future development should be discouraged.

Response: In conducting the analysis of urban flood damages and the ensuing project benefits only present day development is considered. The Corps is researching the field of future urban development benefits and is in the process of formulating a methodology that will provide good estimating techniques. At the present time, the value of future urban benefits is not included in flood damage analysis. When the methodology is sufficiently developed, these benefits will be included in project analysis. We do have techniques for predicting future agricultural benefits and they are included in agricultural flood damage and benefit calculations.

We concur that flood plain development should be regulated; however, the Federal Government does not have authority to regulate development through land use regulation, zoning, or statute. Zoning is a local and state mandate and not under the auspices of Federal jurisdiction. Land use regulation may prevent future damages from occurring but would do little for the existing lands and structures.

Comment 17: Page Two - 30. A more thorough discussion of the cave communities identified on page three - 16 is needed. It should be determined if the Indiana Bat, identified as endangered on the official list of Endangered Species, inhabits any of these caves. Would flooding of caves in the flood pool or conservation pool make death traps of these caves?

Response: See response to the Missouri Speleological Survey Comment 1. Although there are presently no known colonies of endangered bat species present in caves in the Union Lake area, if any of the caves that will be inundated are found to contain endangered bats, the entrances will be sealed prior to inundation at a time when the bats are not in the caves.

Comment 18: Page Two - 43. Previous work in the area (Chapman et al, 1964, and Schneider and Geier 1971) has clearly documented the need for additional survey.

Response: Archeological information presented in the draft environmental statement was based on the existing state of knowledge of archeological resources in the project area. The state of this knowledge in terms of its adequacy is currently under review by a professional archeologist. This review will establish the future course of action with respect to any further archeological investigations undertaken by the Corps of Engineers in the Union Lake project area.

Comment 19: Page Three - 1. It is noted that the period of expected use of the flood pool - March, April, May and June - will be during peak nesting periods of upland game and spawning of warm water fishes in their river. Spawning in the 30 miles of river in the flood pool could be lost.

Response: Concur. The EIS has been changed to include these impacts in paragraphs 4.2.1.6 and 4.2.2.1.

Comment 20: The last sentence in the paragraph on IRON ORE, page three - 10, should be changed to clearly indicate the effects of subordination or acquisition of the development of the known mineral deposits. In this sentence, it should be made clear that it is the development of these deposits that would be affected or unaffected. The statement should also consider the impact of the project on undiscovered mineral deposits that may exist and the search for such deposits.

Response: The final EIS has been changed to further explain these points in paragraph 4.1.6.1.

Comment 21: Page Three - 32. It has not been determined that fish populations will benefit from increasing the period of time they will be subjected to 3/4 bankfill flows, therefore the statement that a maximum flow of water will be a stabilizing factor on the fish population needs some qualifications.

Response: This statement infers that extreme minimum and maximum flow will be eliminated below the dam. Discharges will be maintained near a mean volume, with fewer drastic fluctuations. The reduction in extreme fluctuations is the stabilizing factor on the fish population.

Comment 22: Page Three - 37. All three conversions could have significant impact on plant and animal communities if these conversions ultimately required a higher degree of flood protection which resulted in further alterations to the landscape. Some estimate of how many acres of each type of conversion is expected with completion of the project should be given. The comment by the St. Louis County Planning Commission on page eight - 22 leads us to believe that the Corps has developed this information.

Response: We concur. Land use investigations and project impacts on land use should be investigated. However, the Corps did not analyze land use conversion by acreage and land use type. Rather we investigated the more general trends. Specific land use analysis would be difficult and more speculative and less reliable than most forecasts. Land use is not always a natural expansionary process but may be altered by zoning decisions which have not been formulated.

Comment 23: Page Three - 40. In view of the weaknesses in the wildlife management plans implemented by the Corps of Engineers on existing reservoirs, we strongly recommend that all lands not needed for intensive recreation or project operation and maintenance be dedicated to fish and wildlife conservation purposes in accordance with a General Plan and be made available for management by the Missouri Department of Conservation.

Response: The St. Louis District is developing a progressive wildlife management program on lands it administers that is not outgranted to other agencies. New regulations provide for the preparation of Fish and Wildlife Management Plans as an appendix to the Projects Master Plan. This document provides an operational program funded and staffed by the Corps. The St. Louis District is proceeding with an active, strong wildlife management program on lands it now administers.

Comment 24: Page Three - 45. A special study should be conducted to determine if any threatened species inhabit the caves. Reliance should not be placed on a lack of reported occurrences.

Response: See response to Comment 1 of the Missouri Speleological Survey.

Comment 25: Page Three - 60. The final EIS on Meramec Park Lake identified 440 miles of floatable river in the Meramec Basin and 343 miles within the drainage area of Meramec Park and Union Reservoirs. Construction of the two projects will inundate 19.5% of the total floatable rivers in the entire basin, or 25% of the floatable rivers in the drainage of the two reservoirs. As indicated in the general comments, a study to identify the value of float streams in the Meramec Basin from a national, regional, and local standpoint should be completed.

Response: We agree that a study to evaluate the value of float streams would be a valuable planning tool; however, we believe that this study would be more properly conducted by the Bureau of Outdoor Recreation.

Comment 26: Acquisition or subordination of mineral rights also would affect the wording in Part Seven, irreversible or irretrievable commitment of resources. Acquisition under the joint agreement implies that mineral development would not be permitted and thereby mineral loss to local and national use should be assessed as an irreversible or irretrievable commitment.

Response: Recovery of minerals whether in Federal or private ownership would not be precluded if compatible with project purposes. Recovery would be predicated on the Government's right to regulate development.

9.2.4.9 ADVISORY COUNCIL ON HISTORIC PRESERVATION (letter dated 9 May 1974)

Comment 1: This is in response to your request of February 25, 1974, for comments on the draft environmental statement for the proposed Union Lake, Bourbeuse River, Missouri. The Advisory Council has reviewed the statement and notes that the undertaking will affect the Koenig Site and Noser's Mill properties which may be eligible for inclusion in the National Register.

Response: Comment noted.

Comment 2: Pursuant to Section 2(b) of Executive Order 11593 "Protection and Enhancement of the Cultural Environment" of May 13, 1971, Federal agencies must, prior to the approval of the expenditure of any Federal funds on an undertaking or prior to the granting of any license, permit or other approval of the expenditure of any Federal funds on an undertaking or prior to the granting of any license, permit or other approval for an undertaking, afford the Advisory Council an opportunity to comment on the effect of the undertaking upon properties which may be eligible for inclusion in the National Register of Historic Places. For your convenience, a copy of the Council's "Procedures for the Protection of Historic and Cultural Properties" is enclosed.

Response: Through consultation with staff of the Advisory Council's Washington office it has been determined that a resolution should be made by the Secretary of the Interior as to the eligibility of these sites for inclusion in the National Register prior to following further procedures outlined in section 800.4 of Council guidelines. Since the Noser's Mill site has been determined eligible for the National Register of Historic Places, the St. Louis District will be in contact with the Advisory Council for consultation in complying with Executive Order 11593 as is stated in paragraph 4.3.6 of the final EIS. No determination has been made for the Koenig site.

Comment 3: Until the requirements of the Executive Order are met, the Council considers the draft environmental statement to be incomplete in its treatment of historical, archeological, architectural and cultural resources. To remedy this deficiency, the Council will provide substantive comments on the undertaking's effect on the previously mentioned property through the Section 106 process. Please contact Louis .all of the Advisory Council staff (303-234-4946) to assist you in completing this process as expeditiously as possible.

Response: The St. Louis District has been in contact with the Staff of the Advisory Council and is taking steps to comply with the provisions of the Executive Order as expeditiously as possible. Also see the response to the U. S. Department of Interior Comment No. 1.

9.2.4.10 U. S. DEPARTMENT OF TRANSPORTATION, FEDERAL HIGHWAY ADMINISTRATION (letter dated 1 April 1974)

Comment 1: 1. Part I, Paragraph 11, AUTHORIZATION AND HISTORY OF THE PROJECT gives the estimated cost of relocating Missouri State Highway 185 at a location and elevation compatible with Union Lake requirements to be approximately $3,000,000. It is not clear if this cost is directly related to the Union Lake Project over and above the cost of the reconstruction of Highway 185 if Union Lake were not developed. A clearer explanation of the project's impact upon Highway 185 will be presented if the costs of reconstruction of Highway 185 as a result of the project are compared to the costs of reconstruction without the project in the Final Statement.

Response: The portion of the $3,000,000 cost of relocating Missouri State Highway 185 directly related to the Union Lake project is currently estimated at $2,100,000. The balance of $900,000 is estimated to be the cost of reconstruction of Highway 185 if Union Lake were not constructed. A section describing the relocation of Highway 185 has been added to the Final EIS in PART ONE, paragraph 1.12.5.

Comment 2: 2. Route CC, a part of the Federal-aid System, crosses Big Creek within the Flood Control Pool. Other local roads are also within the Flood Control Pool, however, we could find no discussion on whether protection measures will be taken to prevent damage or failure to these existing roadways due to fluctuating water levels.

Response: The elevation of the floor of the bridge on Route CC at the Big Creek crossing is 645 m.s.l. This elevation is equivalent to a flood, with Union Lake in operation, having a frequency in excess of once in 200 years. This exceeds the design criteria for roads of this traffic classification. No alteration will be required as the possibility of flooding is very remote. The same is true of other lightly traveled roads in the project area which may have structures spanning the theoretical flood control pool whose floor elevations are near or above the flood pool elevation of 651 m.s.l.

Comment 3: 3. Part I, Paragraph IX A, RECREATION, indicates the project will support an annual visitation of 1,878,000 recreationists within the first 5 years of project life, with use expected to increase as facilities are added. Of this, some half a million visitors are to be accommodated on Corps-constructed facilities. Based upon the planning assumption that 80 percent of the visitors come from sources within 100 miles of the project, there may be impacts upon highways leading toward the project from population centers within the 100-mile radius, primarily the St. Louis metropolitan area. When the projected recreational use generated by Union Lake is combined with the projected use to be generated by the Meramec project to the south, it becomes evident that heavy peak traffic flows will occur on I-44 and U.S. Highway 50 west of St. Louis. Those impacts should be discussed in detail.

Response: Concur. A section describing the impacts of recreational visitors on the present highway system has been added to the EIS in paragraph 4.3.7.

Comment 4: 4. Part I, Paragraph XII, PLANS OF OTHER FEDERAL AND STATE AGENCIES. We suggest the plans of the Missouri State Highway Department for Highway 185 be discussed in detail here. Presently, their plans are mentioned in various parts of the Statement with no full discussion in any one place. In addition, information concerning relocation assistance needed as a result of the highway reconstruction should be given.

Response: Concur. A section (1.12.5) has been added under the heading "Plans of Other Federal and State Agencies." This paragraph which discusses the alteration of Route 185 has been excerpted from the Highway Commission's Environmental Impact Statement.

9.2.4.11 U. S. DEPARTMENT OF COMMERCE, THE ASSISTANT SECRETARY FOR SCIENCE AND TECHNOLOGY (letter dated 15 April 1974)

Comment 1: The environmental impact statement indicates that no active commercial fishery exists, but that populations of those species categorized as commercial, namely catfishes and freshwater drum, could increase in the impoundments created by project implementation.

Response: At present there is no commercial fishery planned for Union Lake. However, the Corps will cooperate fully with the Missouri Department of Conservation in developing a commercial fishery in the lake if it appears feasible at a future date.

Comment 2: A search of our geodetic control data publications indicates that construction of the Lake should not result in destruction or damage to any network monuments.

Response: Comment noted.

9.2.4.12 OFFICE OF ECONOMIC OPPORTUNITY (letter dated 22 August 1973)

Comment 1: The Office of Economic Opportunity is in the process of being reorganized. During this period of reorganization, the agency will not undertake any actions with regard to either Environmental Impact Statements or comments as to same, pursuant to the National Environmental Policy Act of 1969. It would be in keeping with the meaning and spirit of the NEPA if future activities were subjected to the Office of Management and Budget Circular A-95 clearinghouse procedures and submitted to interested and affected local community groups and organizations for their review and comments.

Response: Comment noted.

9.[illegible].4.1[illegible] EXECUTIVE OFFICE, STATE OF MISSOURI (letter dated 17 June 1974)

[illegible] At my direction, the appropriate agencies of the state conducted a thorough and objective evaluation of the feasibility and effects of this project, utilizing the EIS and other sources of information. I conclude from this review that Union Lake as proposed would be of high quality for recreational purposes, provide significant opportunities for flatwater recreation and associated activities, create a source of water supply of potential value in future years to area communities, and provide a measure of flood control for the developed areas in the downstream [illegible] of the basin. Although there would be some limited adverse effects [illegible] natural resources of the area, benefits of the project are significant [illegible]; therefore, the project is acceptable to the state.

[illegible] Comment noted.

Comment [illegible]: We did, however, encounter several deficiencies in the EIS [illegible] we hope will be overcome to provide more information toward [illegible] the other Meramec Basin projects.

Response [illegible]: Comment noted.

[illegible] The loss of natural habitat could have a significant impact on [illegible]. It is imperative that the Corps recognize the importance of providing suitable lands for the mitigation of wildlife losses. The [illegible] letter from Mr. Carl R. Noren, Director of the Missouri Department of Conservation, discusses this matter in greater detail.

[illegible] Concur. Approval is currently pending of Design Memorandum No. [illegible] - [illegible] Land Requirements Plan, Public Use. This DM includes recommendations for acquisition of all lands originally requested by the Missouri Department of Conservation. This matter is discussed in paragraph 4.3.[illegible].

Comment [illegible]: It is recommended that present guidelines used in determining [illegible] recreational use of proposed projects be improved in the future so they [illegible] more representative values; this matter is discussed in greater detail in the attached letter from Mr. James L. Wilson, Director of Missouri State Park Board. The University of Missouri - Columbia has designed and applied useful criteria in assessing the recreational benefits of the proposed [illegible] project and may be of service to you in future projects.

Response: See response to Comment 23.

The Corps continues to seek methods of improving the process of estimating [illegible] values. The material from the University of Missouri - Columbia will be evaluated for application to Corps projects.

Comment [illegible]: Information in the EIS regarding agricultural losses should be more detailed and we hope the Corps will emphasize the need for closer scrutiny of the values of permanent loss of farmland in return for increased protection in other areas.

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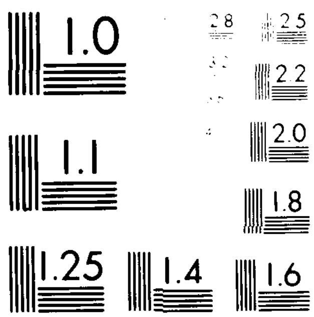
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Response: We concur with the need for additional agricultural data in the EIS. We would, however, like to reassure you that the EIS actually contains a summary analysis of a more detailed investigation that the Corps conducted at an earlier period. A very thorough analysis of agricultural impacts can be found in a document entitled, "Union Lake, Upper Mississippi River Basin, Bourbeuse River, Missouri (General Design Memorandum No. 4)", available for review at the District office. Thus, while the EIS presents summary data, a detailed analysis was done and serves as back-up data.

Comment 6: With regard to water supply, the Missouri Geological Survey has concluded that more groundwater is available in the upper reaches near Sullivan than the EIS indicates; I understand that this conclusion is based on more recent information than was available to you and that this data is being forwarded to your office.

Response: The Corps is aware that enough groundwater exists in the upper basin for the upper basin's needs. The water supply benefits for Union Lake are based on future needs in the lower basin. The use of surface water supplies are discussed in the EIS in the alternatives section in paragraph 6.3.3.4.

Comment 7: These deficiencies made it more difficult to determine the true feasibility and effects of Union Lake. We could not make a determination at this time of Pine Ford, I-38, and Irondale since sufficient information has not been assembled by your office. As studies progress on these remaining three Meramec Basin projects, it is imperative that state government be involved in all phases of the planning process.

Response: The St. Louis District will coordinate closely with the State of Missouri in all phases of any future water resources development in the Meramec Basin.

Comment 8: Missouri has seven District-level Corps offices, each working rather independently on projects in our state. We recommend that the seven districts combine their efforts in determining such essential statewide impacts as the need for outdoor recreation opportunities and the loss of productive farmland and wildlife habitat. In this manner the Corps can assist the state planning efforts considerably. I welcome the initiative you have taken in working with the other District Engineers toward this end.

Response: Comment noted.

Comment 9: Water resource planning in our state is of vital importance since decisions we make today will affect many future generations of Missourians. I endorse Union Lake and believe it will be very beneficial to our citizenry and be of high quality. The opportunity to review and comment on major proposed reservoirs is appreciated and I thank you for your close cooperation.

Response: Comment noted.

Comment 10: Several items of special concern to our Department were noted in reviewing the Corps of Engineers' Draft Environmental Statement for Union Lake (February 1974). One is the proposed warm water hatchery facility downstream of the dam and another the mitigation of terrestrial wildlife habitat losses. Detailed comments on these and various other items are enumerated on the attached sheet.

Response: Comment noted. See replies to Comments 11 and 12.

Comment 11: Provision of water supply facilities capable of serving a warm water hatchery was suggested as a desirable project addition in view of the proximity to metropolitan St. Louis. Future needs for such a facility are not definitely known; however, with the water supply available, developing a hatchery to assist in meeting future metropolitan needs would be greatly simplified.

Response: The Corps of Engineers will make these water supplies available for a warm water fish hatchery as is stated in the EIS.

Comment 12: Of greatest concern are the anticipated adverse project impacts on wildlife as related to the project area terrestrial habitats. These losses have not been quantified in terms of habitat units or values foregone. Contrary to the EIS (Three-37.3. Line 5), techniques do exist for demonstrating impacts on wildlife without and with a project. Personnel of the Bureau of Sport Fisheries and Wildlife and Department of Conservation are prepared in 1974-75 to evaluate the project and its influence area to document the situation. Such data would be valuable for future reference.

Response: District biologists are available to participate with biologists from Missouri and the Bureau of Sport Fisheries and Wildlife to evaluate the Union Lake area's wildlife value.

Comment 13: The project as authorized does not provide for mitigating terrestrial habitat losses. A general evaluation of anticipated project effects on wildlife was made by our personnel. Numerous meetings were held with the federal Bureau of Sport Fisheries and Wildlife and with the St. Louis Corps of Engineers District personnel to discuss and negotiate ways to resolve the problem. General agreement was reached on blocks of upper reservoir border lands that could be developed and managed to partially offset terrestrial losses. Federal construction agency responsibilities for development as to location, amount and type have not been established. Neither has the operation-maintenance responsibility been settled. Since the Office of the Chief of Engineers has not yet approved the recommendation of the St. Louis District for additional lands, we are at a loss to know how to respond. It is definitely in the best interest of the State of Missouri to have these matters with respect to wildlife as fully settled as are the details on other project features.

Response: Concur. Every effort is being made to gain approval of Design Memorandum No. 5 as expressed in No. 3 above. Most recent correspondence on this matter was a letter dated 24 June 1974 from the Division Office at Vicksburg, Mississippi, to the Office of Chief of Engineers, Washington, D. C. This letter urges approval of the Design Memorandum as submitted.

Comment 14: Refer to warm water hatchery. It is good planning and wise to build to meet possible future needs. The Department of Conservation is not now committed to a time table for hatchery construction or even to ever constructing a hatchery.

Response: Concur. The discussions pertaining to the construction and operational commitments in reference to a fish hatchery have been reworded to clarity the State's position.

Comment 15: Clearing of reservoir. Downed timber in some locations could be desirable for its fisheries values. A minimum clearing policy if followed would help achieve maximum reservoir values for fish and wildlife and also to some degree serve in reservoir zoning.

Response: The St. Louis District will coordinate with the Missouri Department of Conservation and other appropriate agencies to determine a clearing policy. This is discussed in paragraph 1.5.2 of the EIS.

Comment 16: Project land additions. Reference is made throughout the report to the proposed acquisition of an additional 4,200 acres in the upper reaches of the lake. The specific location(s) of the lands is not shown on the project maps. Is it definite that the lands will be acquired? Does the 21,993 acres of fee and easement land include the additional lands to be acquired for fish and wildlife purposes? What will be offered under a General Plan?

Response: See responses to comments 3 and 13.

The proposed 21,993 acres of fee and easement lands for the Union Project includes area in the upper reaches of Union Lake. Portions of these areas will be included in the "General Plan and Cooperative Agreement" required for this project under the Fish and Wildlife Coordination Act PL 624.

Comment 17: Acquisition Criteria. Experience on other projects indicates that exceptions to the 300' buffer strip criteria should be kept to the very minimum to prevent future encroachment on project lands and to maintain high aesthetic qualities.

Response: Concur.

Comment 18: Recreation Areas. The Department of Conservation is not at this time committed to manage any recreation areas with facilities developed for high intensity use.

Response: Concur.

Comment 19: Warm water discharge. More accurately stated, a warm water fishery will still be possible downstream. "This provision will insure preservation of the existing downstream fishery" is not necessarily true.

Response: Concur. The Final EIS (paragraph 1.9.5) has been changed to reflect this.

Comment 20: How and when will the "detailed wildlife management plan" be developed? Will implementation, operation and maintenance cost be at project expense?

Response: A wildlife management plan will be prepared by District wildlife biologists in coordination with the Missouri Department of Conservation one to two years before the completion of the project. The plan and its implementation will be paid by operation and maintenance funds.

Comment 21: Total habitat loss is the overriding factor for deer as well as for other species. Cropland represents only a portion of the picture.

Response: This is acknowledged in the opening paragraphs of the chapter. (Paragraph 4.2.3.) The individual paragraphs on game animals attempts to concentrate on the most important individual impacts.

Comment 22: Since mosquitos are excellent fish food, leaving fish cover wherever possible through reduced timber clearing might further alleviate any anticipated problems.

Response: The exact amount of timber to be left standing has not yet been determined, but there will be timber left in the upper portion of the lake and its tributaries to serve as cover for fish.

Comment 23: During our review of the EIS and discussions with the Corps of Engineers, they indicated that the primary recreation market area of a Corps Engineers' lake project is within approximately a 100 mile radius of the project.

In applying this guideline to projects similar to the proposed Union Lake we find that the following existing or proposed projects overlap the Union Lake (Meramec Basin) market area; Carlyle, Shelbyville, and Rend Lakes in Illinois, Lock and Dams 24, 25, and 26 in Missouri and Illinois, Cannon, Long Branch, Harry S. Truman, Stockton, Pomme de Terre, Table Rock, Clearwater, and Wappapello Lakes in Missouri, and Norfolk and Bull Shoals Lakes in Missouri and Arkansas.

This indicates that the market area of the Meramec Basin projects are overlapped by fourteen other projects. Seven of these projects are shown to be competing for the St. Louis Metropolitan market area.

In order to determine the potential visitation to Union Lake and the other Meramec Basin projects it appears that it would be necessary to determine the recreation demand of the market areas for all competing projects and then deduct the existing supply. If this methodology were used it would more clearly reflect the needs that could be met by each project, making it easier to project attendance.

Response: The market area for the reservoirs in the Meramec Basin do overlap with the market areas of existing projects. These overlaps were taken into consideration in calculating the projected visitation for the Meramec Basin projects. Although the market areas overlap, it is usually on the outer fringes of the market areas. The majority of the visitation to a project comes from within the 50 or 75 mile radius. In the case of the Meramec Basin, the recreational demand was calculated for the total basin system of five reservoirs. If some of the five reservoirs are not constructed this will necessitate additional facilities at the constructed projects to accommodate the recreational demand of the basin. This district has proposed to accomplish a study to determine the total statewide outdoor recreational demand plus a 100-mile radius around the State of Missouri. In the methodology to estimate the recreational demand for a proposed project, similar projects are evaluated. Some of the considerations used in the methodology are size of reservoir, shoreline miles, location of the reservoir to urban centers, and the recreational pursuits for which the reservoir is suited.

Comment 24: The EIS states the lake will ". . .increase the opportunity for recreation on the 32 miles of the Bourbeuse River below the dam and 60 miles on the Meramec River. . ."

The Corps of Engineers is acquiring land immediately below the dam that could be developed for access to the river. Additional facilities should be provided, as part of this project, to provide access to the lower reaches of the improved stretches of river.

Response: Although development plans have not been prepared as yet, a small boat launching complex could be provided at the downstream access area. This will be considered during preparation of the Union Lake Master Plan. In addition, as part of the Meramec Basin plan, 19 angler use areas, shown on PLATE 1, SECTION ONE, are planned.

Comment 25: The Corps of Engineers should complete a survey of project lands identifying potential sites that might qualify for nomination to the National Register of Historic Places. The final disposition of these sites should be discussed.

Response: See response to U. S. Department of Interior's comment No. 1.

Comment 26: More consideration should be given to the discussion of site analysis in relation to the carrying capacity of recreational areas.

Response: Concur. The Land Requirements Plan and the Master Plan will discuss this subject more fully.

Comment 27: On Page Two-50, Montauk State Park should not be listed as being in the Meramec Basin.

Response: Concur. The final EIS (paragraph 2.3.7.2) has been changed.

Comment 28: Population projections should be given for the entire project market area, not just Franklin County.

Response: The population projection for Franklin County was offered in connection with assessing the socio-economic impacts the proposed project would have on the immediate area. Using population projections from the Office of Planning and Analysis, Executive Office of the Governor, State of Illinois, and the Office of Administrative Services, Comptroller and Budget Director, State of Missouri, a projection of the market area (100 mile radius from the dam site) is readily generated. The following projection shows that the market area will experience a steady growth through 1990:

1970	1975	1980	1985	1990
2,378,990	2,693,396	2,889,237	3,071,102	3,217,412

Comment 29: As a result of this review it is my opinion that the State of Missouri should continue to support the Union Lake project.

Response: Comment noted.

9.2.4.14 MISSOURI STATE PARK BOARD (letter dated 26 April 1974)

Comment 1: The State Historical Survey and Planning Office has reviewed the Draft Environmental Impact Statement for the Union Reservoir on behalf of Mr. James L. Wilson, Missouri's State Historic Preservation Officer. Although there are no sites currently listed on the National Register of Historic Places in the project area, two sites are under study as mentioned in the Statement. These are the Koenig Shelter and Noser's Mill. These sites will be presented to the Missouri Advisory Council on Historic Preservation for their recommendations at their June meeting. Meanwhile, these sites have been submitted to the Secretary of the Interior for determination as to their worthiness under the provisions of Section 2(b) of Executive Order 11593. When such a determination is made, these sites will receive the full protection of Section 106 of the Historic Preservation Act of 1966.

Response: Comment noted.

Comment 2: The sections on the historical resources of the area are far from complete. A brief perusal of Caldwell's Historic Sites Catalogue and two interviews do not constitute an adequate survey of this area. A cursory survey, undertaken by two of our staff members in early April revealed many mid and late nineteenth century structures that appear to meet the criteria for the National Register of Historic Places. With the exception of the Noser's Mill discussion, it becomes apparent that little or no field survey of the area has been conducted by a competent historian and/or architectural historian as required by Executive Order 11593. We highly recommend such a survey prior to preparation of the Final Environmental Statement.

Response: See response to U. S. Department of Interior's comment No. 1.

Comment 3: Although an archaeological survey of the area has been made under the provisions of the Reservoir Salvage Act of 1960, it must be remembered that such a survey does not necessarily fulfill the requirements of either the National Environmental Policy Act or Executive Order 11593. Shoreline sites affected by wave action and erosion, sites in the flood pool elevations that will be affected by a fluctuating water table, and sites in the public access and recreation areas should be surveyed to supplement the past data and complete the prehistoric inventory of the area.

Response: See response to U. S. Department of Interior's comment No. 1.

9.3 CITIZENS GROUPS AND INDIVIDUALS

9.3.1 GENERAL

As described in paragraph 9.1, citizen participation has been a continuing part of planning of this project. In recent years private conservation organizations, especially the Coalition for the Environment, St. Louis Region, and the Ozark Chapter of the Sierra Club, have expressed their concerns regarding water resource developments in the Meramec Basin, especially Meramec Park Lake.

9.3.2 COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The following are comments received from citizens groups and individuals. Following each comment is the response.

9.3.2.1 MERAMEC BASIN ASSOCIATION (letter dated 15 April 1974)

Comment 1: The statement covers the subject and is well done. It reflects the planning that has been done on the lake through the careful and comprehensive investigation, and the coordinated effort thereon, by local, state and federal interests. Backed by the Basin-wide environmental study by your office, and with the extensive coverage of subject matter in the statement itself, it constitutes a proper expression under the law of the various impacts that go with the project.

Response: Comment noted.

Comment 2: There is no doubt in the view of the Association that Union Lake is the most suitable alternative for handling the needs of the people and resources of the area, as provided for in the Basin plan.

Response: Comment noted.

Comment 3: The Meramec Basin Association continues its endorsement of this project.

Response: Comment noted.

9.3.2.2. MISSOURI SPELEOLOGICAL SURVEY INC. (letter dated 15 April 1974)

Comment 1: I am writing this letter in response to your letter of February 25, 1974 in which you solicit the comments of the Missouri Speleological Survey on the Draft Environmental Statement Union Lake Bourbeuse River Missouri. The Missouri Speleological Survey has for the better part of the last two decades attempted to locate, record, explore, conserve and research the ecology of caves in the state of Missouri. As a result of our efforts in pursuant of the above mentioned activities, we have established certain informational guidelines which we consider essential for the development of an adequate understanding of the environment of a given cave. These guidelines are considered minimal and in no way represent the optimum coverage for a given cave. It is the feeling of the Missouri Speleological Survey (as clearly indicated to the UnitedStates Army Corps of Engineers in a communication from Missouri Speleological Survey on May 8, 1973 relating to the revised and supplemented Draft Environmental Statement for Meramec Park Lake and Meramec Park River) that any Environmental Impact Statement which seeks to conform to the intent and purpose of the National Environmental Policies Act of 1969, PL-190 should contain the following data on each and every cave within the area involved:

MISSOURI SPELEOLOGICAL SURVEY CAVE REPORT GUIDE LIST

1. Narrative description of the cave containing all significant aspects of the cave.
2. Geological report. This should indicate all important geological aspects of the cave, such as the formation in which the cave is developed, general developmental patterns, and specific geological aspects of importance in the cave.
3. Hydrological report. Description of the hydrology of the cave itself and particularly the relationship between the cave and the general hydrological aspects of the area in which it is found.
4. Biological report. A listing of all species of life found in the cave, including data concerning populations of various species, and habitat locations within the cave.
5. Cave map. It is considered essential for any adequate understanding of the cave to possess a relatively high quality map which allows for the geological, hydrological and biological reports above to be placed in the context of a specific cave and thereby allow for the development of an understanding of these three variables' relationship to one another.
6. Entry photographs and photographs of significant aspects of given caves.
7. Additional reports concerning such topics as archeological and paleontological aspects where necessary.

Response: The data presented in the EIS represents the best data available to the District and is thought to represent the most accurate assemblage of information available at this time. The final EIS will be amended if additional significant information becomes available.

Comment 2: The Draft Environmental Statement Union Lake Bourbeuse River Missouri is unquestionably inadequate. It does not contain for any of the caves in the project area even one of the seven necessary reports referred to above. The Missouri Speleological Survey is somewhat dismayed over what can only be interpreted as a flagrant disregard for National Law. The Missouri Speleological Survey would like to request that the United States Corps of Engineers seek to comply with the purpose and intent of the National Environmental Policies Act of 1969 and modify the current Draft Environmental Statement in such a way so as to provide an adequate understanding of the speleological environment of the area in question.

Response: Comment noted, see response to Comment 1.

9.3.2.3 CITIZENS COMMITTEE TO SAVE THE MERAMEC, INC. (letter dated 5 April 1974)

Comment 1: Once again the Corps of Engineers has done a very admirable job of compiling a literal wealth of figures and statistics. The careful study of these volumes will, no doubt, bring a far greater understanding of the Bourbeuse River system to a relatively few people.

In depth this Environmental Statement, although quanitatively impressive, seems to be beating the same old drum for the same old reasons. Taken in the order of their economic importance we have the seven project purposes as follows:

Response: Comment noted.

Comment 2: Recreation is at present a very important part of the activity in the Meramec Basin which includes the Bourbeuse River System. The only forms of recreation activities that would be enhanced by the installation of impoundments are water skiing and power boating, which according to the Outdoor Recreation Resources Review Commission will comprise only 5% of future recreation demands. Activities such as stream fishing, hunting, river boating and canoeing, nature study, and the simple enjoyment of a rural setting in a natural environment, will all be drastically diminished by the completion of the Union Dam.

Response: Recreational opportunities in the Bourbeuse River are limited because of lack of access. The recreational activities planned for Union Lake are broader in scope than water skiing and power boating and include: swimming, sightseeing, picnicking, fishing, boating, nature walks, camping, water skiing, hiking and hunting. It is noted in the EIS (paragraph 4.3.4.4) that float fishing and canoeing will be diminished by Union Lake.

Comment 3: All future recreation needs of the Basin can be easily met by the strategic installation and maintenance of open space parks and access points along the river. The requirements of the Metropolitan St. Louis Area can far more adequately be served by a Lower Meramec Recreation Area at just a fraction of the cost of the now proposed Meramec Basin Plan. The adoption of such a plan would also serve the purpose of flood control by negating the possibility of urban encroachment on the flood plain.

Response: The provision of recreational open space in the lower basin would be of great benefit to the people of St. Louis and vicinity. This alternative is discussed in the alternatives Section of the EIS (paragraph 6.3.2.3). However, open space parks and access points would not satisfy the demand for flat water recreation; nor would it fulfill the need for water supply and flood protection to those residences and businesses that are subject to flood damages.

Comment 4: The Statement assigns a questionably large figure to the recreation benefit to be derived from the Union Lake. It is not at all clear whether the Corps has assigned dollar values to the recreational activities lost to the project or whether this figure is considered in the cost column.

Response: The construction of additional multi-purpose reservoirs will serve to attract recreationists from competing activities but there are two factors which must be weighed as important considerations. One, competition between economic activities tends to promote price stability and increases in quality. Thus it is not clear to us that competitive recreation activities leads to income losses. It does lead to lower prices for the ultimate consumer of the activity. Lower prices can be viewed as dollar value loss to a competing enterprise but a savings to the recreationist. No real (net) loss occurs. Secondly, in the short run, added water resources for recreation purposes may actually create a surplus but in the long run there will be a need. We plan projects for 100 year life spans and while this may create short run surpluses it fulfills long-run needs.

Comment 5: Man has been practicing structural flood control for 4000 years with approximately the same degree of failure each and every year. We spend ever increasing millions and even billions on flood control projects and our flood losses have risen more than tenfold since the 1930's. It is high time we stop trying to regulate the apparently uncontrolable flood waters and concentrate on the folly of placing development in their path.

Response: The value of structural flood control by the construction of levees, floodwalls and reservoirs is well documented. For example, the local St. Louis Flood Protection Project consisting of levees and floodwalls was constructed at a cost of $85,000,000. During the 1973 Mississippi River flood more than $160,660,000 of damage was prevented.

The increase in annual flood losses is due to the ever-expanding population and its need for a place to live and support itself by economic endeavor. The method of effecting the prevention of flood damages is governed by the circumstances and conditions of the particular case. In the Meramec Basin the construction of Union Lake is an effective means of flood damage prevention, especially in the absence of any land use controls.

Comment 6: This Statement indicates that 8,574 acres of agricultural land will be irretrievely committed to the project. I found no indication of the value of the product from this land or that the particular value is, as well, a cost of the project. This should be incorporated.

Response: As a result of the construction of the Union Reservoir, 8,574 acres of agricultural land will be lost to production. The Corps has conducted intensive research to evaluate and analyze the benefits and costs associated with the utilization of said land. Crop acreage, crop projections, distribution, productivity, cost elements of a fixed and variable nature, soil characteristics, and related factors were analyzed. The resulting effort led to a 50 page report which summarizes the Corps' investigative effort. The concensus of this document entitled, "Meramec River, Missouri, Comprehensive Basin Study, Volume VII," would be too lengthy to presnet in a short response. It is available at the District Office for inspection.

Comment 7: The arbitrary practice of increasing stream flows to abate pollution during low flow periods is clearly contrary to directives expressed in the Federal Water Pollution Control Act, and requires no further comment.

Response: See response to Environmental Protection Agency Comment 10.

Comment 8: The Missouri Geological Survey and Water Resources states that the ground water supply in the Meramec Basin is adaquate to meet all foreseeable needs. The Corps has again used questionably large population and demand figures in projecting future water needs in the Lower Basin. These requirements could yet be more adaquately met with water from the Missouri-Mississippi System, one of the mightiest river systems on Earth.

Response: The Missouri Geological Survey and Water Resources Division's statement applied only to the upper Meramec Basin. However, the City of Sullivan in the upper Meramec Basin, has recently experienced difficulty with the deep wells upon which it relies for water. The lake adjacent to the city would provide a reliable source of water which could probably be more economically pumped into the distribution system. In the lower basin ground water is supplemented by withdrawals from the Meramec and Missouri Rivers. Water supply requirements were furnished by the Public Health Service on a seasonal basis for three time periods - 1970, 2020, 2070. Based on these data, supplemental water supply requirements were determined. It was found that by utilizing all available sources, the project requirement in the lower basin can be satisfied until about the year 1980, after which other sources will need to be developed. The St. Louis County Water Company has confirmed the need for additional water supply in the lower basin. On September 29, 1971, the utility filed an application to install a second pumping plant on the lower Meramec River below State Highway 30 crossing near the town of Fenton, Missouri. Union Lake, which has an assigned economic life of 100 years, will be able to supply a minimum of 71 million gallons of water per day. As discussed in the alternative section of the EIS, the furnishing of water to meet lower basin needs from a multi-purpose project such as Union Lake was found to be the most economic alternative. At the same time the water supply storage afforded recreation and streamflow augmentation benefits when not required to meet the need for water.

Comment 9: It is far more economical to utilize ground water supplies which require no elaborate purification. The cost of purifying surface waters in relation to drilling wells is tremendous.

Response: See response to Comment 8.

Comment 10: The Meramec Basin is blessed with one of the highest quality ground water supplies in the Nation. The completion of proposed Corps of Engineers projects would place this resource under the threat of irrevocable contamination by leakage of surface waters into the ground water supply. We have no assurance that such a catastrophy would not occur. The Draft EIS states, "Drilled wells within the lake and project boundaries would be sealed or plugged in a manner to prevent pollution of ground water." Our water supply is perhaps our greatest gift from nature. The possibility of its contamination is in itself enough reason to abandon the Union Lake and the entire Meramec Basin Plan.

Response: The ground water near Union Lake will be tributary to the lake. It will replenish the lake water rather than the lake recharging the ground water aquifers. If water wells are installed close to the reservoir and pumped to the extent that they draw the ground water levels down below the lake level, then a situation would exist where the lake would locally and temporarily recharge the ground water depression created by pumping. In this case, pollutants that might be in the lake could be drawn into the ground water system. Water quality of the lake will be good, however, and the possibility of significant or irrevocable contamination of ground water in this manner is considered extremely remote. Even so, as stated in the EIS, proper regulatory control is necessary to provide a high degree of protection against pollution of ground water. Plugging of wells within the lake or project boundary will be part of this regulatory control. Completion of the proposed Corps of Engineers projects in the Meramec Basin will not be a threat of irrevocable contamination of ground water supply.

Comment 11: Webster defines the word conservation thusly:

(1) a conserving; protection from loss, waste, etc.

(2) the official care and protection of forests, rivers, etc.

We suggest the word, conservation, be deleted from this heading as the project does not involve itself with conserving numbers or species of fish, wildlife, or vegetation.

Response: It is correct that biological diversity in the area will decrease with Union Lake; however, conservation practices will be applied to other resources such as protecting the water in the lake and developing wildlife management plans for project lands.

Comment 12: A net increase of 250,690 annual fisherman days is claimed by the project, including 10,320 days on the downstream reaches. We wonder if this figure is also included in the 18,000 days claimed for the downstream reaches of the Meramec Park Dam, and whether proper account was taken of the fishing activity now existing without the project.

Response: These figures were provided to the St. Louis District by the U. S. Bureau of Sport Fisheries and Wildlife, in a letter dated 28 January 1964.

Comment 13: The Missouri Department of Conservation has agreed to build only a fish hatchery below Meramec Park Dam. We've seen no evidence to indicate funding or authorization for similiar development at other sites is available. It seems the Corps is trying to sell this question on "could be" rather than "will be". A similiar situation exists in the coordination with the Missouri State Parks Board with regard to state participation in recreation areas near the lake.

Response: The discussions pertaining to the construction and operational commitments in reference to a fish hatchery have been reworded to clarify the State's position.

Comment 14: The entire fish and wildlife benefit could be accomplished far more realistically and economically through other non-structural means, thereby holding true to the meaning of the term "conservation".

Response: It is true that greater fish and wildlife benefits could be accomplished by non-structural methods; however, the other project purposes of flood control, recreation, regulation of stream flow, water supply, area development, and increased navigation on the Mississippi River would not be met.

Comment 15: The benefits of local economic development are another myth aimed at selling the project on "could be". The logic involved in assuming the labor force utilized in construction of the project would otherwise be unemployed is not evident. It is also pertinent that all Corps projects that we have the particular information on were built by non-local contractors, usually from out-of-state. A recent example is the award of contract for construction of the access road and Administration Building at proposed Meramec Park Lake. This Contract went to a company from Nebraska.

Response: The logic involved in employing what would otherwise be unemployed labor resources is an assumption only in part. During the plan formulation of project analysis, the Corps systematically evaluates the potential benefits attributable to employing the unemployed for project construction purposes. These manpower needs should be viewed as an average or estimated component which will undoubtedly be either an under or overstatement of what actually occurs. When observed on a larger scale, i.e., many projects across the nation, Corps estimates are reasonably close. Construction contracts are awarded to the firm which provides for the lowest cost estimates while maintaining acceptable standards. Costs are a major factor in project viability, and we make every effort to allocate public funds as efficiently as possible. If an out-of-state firm can provide the same services, products, and quality as a local company, but at less cost, this firm is awarded the contract.

Comment 16: The other more publicized economic benefit of a tourist economy seems to be, at best, superficial. Ultimately, local governmently agencies would be required to procide all municipal services to this economy without sufficient taxation and revenue returns. Our original and now permanent economy would be replaced or controlled by one of non-local conglomerate type investments. This type of activity brings only a relatively few menial wages into the local community and the bulk of the revenues pass through and out of the area.

Response: A tourist industry which has been successfully integrated into a local economy can provide a major investment incentive. The degree of benefits and costs will depend upon many interacting economic and socio-economic factors. The major forces at work which tend to dampen the beneficial amenities would include:

(1) a lack of local zoning laws
(2) structural imbalance in local industrial employment
(3) income multiplier leakages
(4) an absence of comprehensive local planning

Initially, local Government financial structure suffers a decline in income via tax base erosion and increased expenses on local services such as road repair, police protection, and related social overhead expenses. Our information shows that in the long run most local Governments more than recover these losses. Further, there is no evidence that multi-purpose reservoirs have caused any long-term detriments to local or regional economies.

Comment 17: House Document #686 states that maximum development of reservoirs in the Meramec Basin would amount to a reduction in the Mississippi flood stage of less than one tenth of one foot on the Cairo gage. In view of the insignificant contribution the Basin makes to the Mississippi System, any benefit to navigation seems to be rather marginal.

Response: The navigation benefits derived from Union Lake is achieved incidentally on the Mississippi River during low flow periods by releases for water supply, low flow augmentation and downstream fisheries enhancement.

Comment 18: The Union Lake Project and Meramec Basin Plan are based on antiquated needs and trumped-up requirements. All seven project purposes can be either accomplished through other more acceptable means, or are not valid.

Response: The need for flood control, recreation, water supply, stream flow augmentation, fish and wildlife conservation, and area redevelopment in the Meramec Basin is current. This has been testified to and confirmed by the statements submitted to Congressional Committees by the various Governors of Missouri, members of the Missouri Congressional delegations, public officials of the state, counties and towns and individuals living in and adjacent to the Meramec Basin. The project purposes of Union Lake and alternative means of achieving them are discussed in the draft EIS. No alternative plan of meeting the basin needs satisfied by Union Lake was found to be as effective.

Comment 19: The project is a vital link in the proposes Basin Plan. The "Plan" and the "Projects" are mutually dependent upon each other. This statement is incomplete as it deals only with the Bourbeuse Project and not the over-all Basin Plan.

Response: Please refer to response to Department of Housing and Urban Development Comment 1.

Comment 20: We realize that The Corps of ~~Engineers probably has~~ a very real and worthwhile role in our present day economy. We suggest they relinquish all activity in the Meramec Basin and get at these other more important tasks.

Response: Comment noted.

9.3.2.4 MISSOURI CHAPTER OF THE AMERICAN FISHERIES SOCIETY
(letter dated 18 March 1974)

Comment 1: We have received for review the Draft Environmental Statement for Union Lake, Bourbeuse River, Missouri. We appreciate the opportunity to comment and will forward our comments to you by April 15, 1974.

Please address future correspondence involving the Missouri Chapter, American Fisheries Society, to me at the above Lohman address.

Response: Comment noted. No further comments have been received.

9.3.2.5 MAX ALLEN NICKERSON
(letter dated 5 April 1974)

Comment 1: On page three - 36 of this statement under (2) (a) amphibians is the statement that, "All of the species that occur in the project area are expected to continue existence in that area." There is every probability that this statement is incorrect! The primitive giant salamander, Cryptobranchus alleganiensis (Hellbender) is a resident of the Bourbeuse River (Nickerson & Mays, 1973b). Its populations are rapidly declining

throughout its range and it is a valuable ($15 - $35 live) economic species (Nickerson & Mays, 1973b). It is known that populations "die-off" when reservoirs are constructed (Gentry, 1955). The reasons for death are now established! Although they have lungs, probably hydrostatic structures, their respiration is primarily cutaneous (Guimond & Hutchison, 1973). Their epidermis is somewhat thick and only the lateral folds are highly cutaneous (Noble, 1925). The hemoglobins have a low oxygen holding capacity and Missouri populations are biochemically and physiologically unique in having a single hemoglobin which has no Bohr effect (Taketa & Nickerson, 1973a; 1973b). This may add to the actual commercial scientific values of Missouri populations! A great number of researchers are currently studying these (Nickerson & Mays, 1973b). Cyrptobranchus can withstand higher temperatures than many suspect (Hutchison et al., 1973). However, they can do so only by behavioral adaptations, with great energy expense ("rocking"), and only then if the water is reasonably well oxygenated. In Southern Missouri Cryptobranchus move to riffles when water temperatures reach 70-72° F. They actually move from highly oxygenated still water to highly oxygenated moving water (Nickerson & Mays, 1973a; 1973b). A dam would destroy this habitat and Cryptobranchus populations.

Response: Concur. The final EIS (paragraph 4.2.2.1) has been changed to incorporate this comment.

Comment 2: In one Missouri river (North Fork of the White River), Cryptobranchus populations may reach a density of one hellbender/8-10 sq. meters. From a strictly economic viewpoint this could mean, $15-35/8-10 sq. meters in commercial retail value. Even a preserved specimen, with no data, brought $4 in 1969 and more today (Nickerson & Mays, 1973a; 1973b).

Response: Concur. This comment has been incorporated in the final EIS in paragraph 4.2.2.1.

9.3.2.6 PAUL L. REDFEARN, JR. (letter dated 16 April 1974)

Comment 1: 1. I am extremely skeptical of the data provided on the vegetation within the proposed lake. The data is very general and inaccurate. For example, the flora of the Meramec basin listed in Table 18 (not 21 as referred to on page B-1) is inaccurate. Taking just the first page alone there are more than a dozen species that are not known from the area of the lake or even the Meramec River Basin. I suspect that the compiler never set foot in the field. It appears that it was compiled from Steyermark's flora of Missouri. It in no way represents what is actually known to be present.

Response: This table was compiled for the St. Louis District by a contractor. The data was taken from Steyermark's Flora of Missouri, as is acknowledged in the table. To the best of the District's knowledge it is accurate as far as the county that each species is found lies partly or wholly in the Meramec Basin.

Comment 2: The site data for forest composition is also suspect. No reliable field data is cited and no indication of the extent of each type of forest site is indicated.

Response: The type and extent of forest site data presented is that which is intended to give an overview of the character of the forest. All information presented under site-type descriptions is based upon experienced judgement and information obtained from experienced field personnel. Field data is not cited, because no specific plots were laid out nor inventoried. The degree of intensity of investigation undertaken was judged to be consonant with the needs of the study. There was no intent to furnish a detailed map showing specific plant communities since such detailed information was not deemed to be within the scope of this study.

Comment 3: Without spending an inordinate amount of my time I cannot begin to list all of the inaccuracies I have noted on botanical data alone. If the rest of the report has been prepared as carelessly, then heaven help the people who must use this report for making an evaluation of this project.

Response: Comment noted. Any specific criticisms would be welcome.

Comment 4: 2. I do not find any meaningful analysis of the loss of agricultural land in the area. The U. S. can ill afford to lose much more agricultural land. How much agricultural land are we sacrificing to "protect" downstream bottomland from flooding. Nor is the argument, put forth in several places in this report, that the area might be damaged by urban development if not controlled very convincing. The answer to this problem should be better land use policy, not flooding it.

Response: The construction of the Union Reservoir will result in the loss of 8,514 agricultural acres for project purposes as noted in the EIS. Those acreages are located along the Bourbeuse River. The agricultural acres which will receive protection include (1) 7,020 acres along the Bourbeuse downstream from the damsite, and (2) partial protection for 21,920 agricultural acres along the Meramec River.

We concur with the proposition that land use planning may be a viable alternative, but this alternative would not satisfy all the needs of the basin such as water supply, recreation, navigation, and redevelopment. If the Union Reservoir is not built, these benefit components will be lost. Secondly, land use planning is not a Federal Government responsibility. By law, land use policy is a state and local affair.

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LETTERS RECEIVED BY THE

DISTRICT ENGINEER ON THE

DRAFT ENVIRONMENTAL STATEMENT

APPENDIX A

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United States Senate

COMMITTEE ON APPROPRIATIONS
WASHINGTON, D.C. 20510

March 5, 1974

Col. Thorwald R. Peterson
District Engineer
U.S. Army Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Peterson:

Thank you for sending me a copy of the Draft Environmental Impact Statement for Union Lake, Bourbeuse River, Missouri. I found it to be quite interesting and know my staff will find it to be helpful.

Yours very truly,

Tom Eagleton

THOMAS F. EAGLETON
United States Senator

TFE/df

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA 19082
TELEPHONE (215) 597-3772

8400
March 28, 1974

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Reference is made to your circular of February [illegible] transmitting a copy of the Draft Environmental Statement for Union Lake, Bourbeuse River, Missouri, for review and comment. The copy sent to the Regional Forester in Milwaukee has also been forwarded to this office since national forest lands are not involved. Therefor, the following constitute the comments of the Forest Service.

Our major comments concern the Alternatives, and must take the form of a question concerning the relationship of the proposed action and the alternatives to "The Meramec River Comprehensive Basin Study." The paragraph of the Draft found under that heading appears to differentiate between the conclusions of the "Framework plan" and of the "study." The paragraph states that "inter-agency agreement was reached as to a framework plan, composed of watershed treatment of agricultural lands and forest improvement in the upper Basin, multiple-purpose storage reservoirs on the main streams and
1 tributaries, and levees or flood plain regulations in the lower basin.... It was the conclusion of the study that these needs (flood control, recreation, water supply, water quality control, fish and wildlife conservation, etc.) could be fully satisfied by a series of mainstem, headwater and tributary reservoirs, and several levee projects." These two sentences do not seem to us to be consistent. One states that a comprehensive approach to the Basin's problems, incorporating both structural and non-structural measures was agreed upon, while the second states that the study found that all needs could be satisfied by structural measures alone.

Moreover, where the Draft discusses nonstructural flood damage protection measures, and combinations of such measures with structural measures as alternatives considered, it does not include "watershed
2 treatment and forest improvement in the upper Basin" among the nonstructural measures. We realize that in considering and discussing alternatives, you cannot discuss every possible combination, but one alternative which we think should be included is the comprehensive approach envisioned in river basin studies.

3 XII. PLANS OF OTHER FEDERAL AND STATE AGENCIES (page One-22) states that Lake I-26 on the West Fork of the Huzzah is in the detailed planning stage. This site has proved to be unfeasible and a new site has been located. The I-26 project has been replaced by a site on Barney Fork, a tributary of the West Fork of the Huzzah, and has been designated as the Barney Fork Project.

Our remaining comments are of a minor nature.

4 We note that 12,733 acres of "brush and timber" will be acquired in fee for the project, with easements on an additional 374 acres, a total of 13,107 according to page One-14. Part Seven states that 4,417 acres will be inundated at normal pool, with preservation of most of the remaining 9,002 acres, a total of 13,419. This may indicate some need for reconciliation of data. About 1,494 acres of land will be subject to inundation about every two years, and an additional 735 acres every five years; we don't know how much of these areas are forested, but a problem of death of trees due to inundation usually develops.

5 In Section II BIOLOGICAL ELEMENTS, the final sentence of (3) Site-type III (Slopes) refers to oaks, hickories, maples and other species as "dominant understory species." Oaks and hickories (and possibly maples) are the dominant overstory genera, and the others named are understory species. (When we tried to check this statement against the Technical Appendix, we found only the oaks and hickories referred to, so the basis for the statement apparently is elsewhere.)

6 Except for our major comment above, we feel that the Draft does a good job of meeting NEPA requirements. We think that the discussion of IMPACT ON TERRESTRIAL ORGANISMS DOWNSTREAM OF THE RESERVOIR is particularly good.

We appreciate the opportunity to review and comment on the Draft.

Sincerely,

ROBERT D. RAISCH
Director

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. Box 459, Columbia, Missouri 65201

April 2, 1974

Mr. Jack R. Niemi, Chief,
Engineering Division
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Subject: LMSED-BR

We have reviewed the Draft Environmental Statement for Union Lake, Bourbeuse River, Missouri.

We have the following comments:

1 Table 9 is supposed to show the percentage of soil types in the basin, but it does not have this information included.

We have no other comments on this Draft Environmental Statement.

We appreciate the opportunity to review and comment.

Sincerely,

Douglas R. ... Acting

J. Vernon Martin
State Conservationist

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
1735 BALTIMORE – ROOM 249
KANSAS CITY, MISSOURI 64108

April 16, 1974

Colonel Thorwald R. Peterson
District Engineer
Corps of Engineers
St. Louis District
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Peterson:

We have reviewed the Draft Environmental Impact Statement for the Union Lake Project, Bourbeuse River, Missouri. The project and statement are rated ER-2, indicating we have reservations concerning the environmental effects of certain aspects of the proposed action. We also believe that additional information should be included in the final impact statement to fully assess the environmental impact of the proposed action. Although our basic concern is air, noise and water quality, we have included our general comments. The following comments should be addressed in the final environmental impact statement:

Air Quality

1 The environmental protection provisions mentioned in the impact of construction, (Three-1) should be explained in greater detail. Specifically, more information should be provided on method(s) of preventing fugitive emissions of smoke and particulate material associated with waste disposal and construction practices. Applicable regulations should be cited.

2 The methods of disposal of clearing spoil such as trees, roots, etc. should be identified. We believe burning should be considered only after disposal by other methods has been fully investigated and determined unacceptable or infeasible. Burning should be coordinated with state and local governments to ensure that burning will not be in violation of state or local regulations. If disposal by burning is adopted a method such as forced air open-pit burning should be used to reduce particulate emissions to the atmosphere.

3 Traffic volumes should be projected for the proposed recreational areas to permit an assessment of potential air quality levels.

Noise

Predicted volumes of recreation vehicles associated with
recreational areas, the lake and surrounding project area should
be included. This information is pertinent for noise analysis in
4 sensitive areas both in and around the present and future Union
Lake park areas. Noise levels associated with construction should
be included to assess potential noise related impacts in the Bourbeuse
River Basin, and specifically, the Union Lake Area.

Water Quality

In order to assess the future water quality of the lake, soils
and vegetation should be investigated to determine the amount of
organics present in the soil. From this assessment the amounts of
leachable color, nutrients, organic acids and change in pH should
5 be determined. Additional analysis can provide an indication of
inorganic salts which may increase the total dissolved solids in the
lake. These aspects should be included in the final environmental
impact statement.

In reference to water quality parameters in the Union Lake Area;
values of ammonia were recorded as 0.25-0.55 mg/l (P-110). An ex-
planation of these values should be included particularly what
6 parameters are actually being measured and what effect the potential
alkaline conditions will have on the release of free ammonia. This
information is essential in permitting an assessment of potential
water quality in Union Lake for aquatic life and water supply.

It is stated on Page P-40 that domestic water related problems
may affect public health. This should be explained in greater
7 detail. Coupled with the potential feedlot runoff this would in-
crease the potential of possible public health problems within the
project area. This potential should be documented along with in-
formation as to control and/or abatement of such hazards.

The statement, "Industrial discharge does not seem to be of
significant pollution potential," should be expanded. Industrial
discharge points should be identified for potential influx into
8 Union Lake. These discharge points may have potential water
quality related problems because of industrial expansion. Therefore
a recognition of these possible sources of water quality degradation
should be included in the final statement.

The statement should also identify the location, type and degree
9 of treatment, and discharge for waste treatment facilities and
the methods of disposal of solid wastes particularly in recreation
areas.

10 Under our present policy, we cannot approve the allocation of storage for water quality control in Union Lake. Section 102(b)(3) of the Federal Water Pollution Control Act Amendments of 1972 states in part, "The need for, the value of, and the impact of, storage for water quality control shall be determined by the Administrator..."

11 Waste discharges below Union Lake project should be sufficiently treated at the source to maintain water quality as indicated in the water quality standard, Meramec River and Tributaries, Missouri Water Pollution Board, June 1968.

GENERAL COMMENTS

Flow Characteristics:

12 Reference was made to the downstream enhancement of wildlife and related stream organisms due to controlled stream flow. It should be stated that the stream fluctuations associated with the Bourbeuse River are natural to the existing environment, in that the aquatic organisms are adapted to the seasonal fluctuations of the river flow. It should also state that with this project these fluctuations will be eliminated.

Water Supply:

13 The information on water supply attributed to the Union Lake project should include additional information on future users. Specifically, it should identify which municipalities above the dam are potential users of water supply storage.

Planning and Zoning:

14 The documentation on planning and zoning of the surrounding area of the project indicates that growth around the project area will generally be uncontrolled. The major concern is with non-project areas which are the responsibility of local governments. The growth of the area will proceed with or without the project, however, an accelerated situation will exist if the project is approved. We suggest that non-project area planning of the entire basin be implemented prior to project approval.

15 Planning is also necessary to control waste treatment systems at commercial facilities and residential developments around the lake. Individual septic tanks and private waste treatment systems are often poorly operated and could result in extensive water quality problems in the lake.

We appreciate this opportunity to review and comment on
the draft environmental impact statement. Please forward a
16 copy of the final environmental impact statement to us with re-
view comments when it is sent to the Council on Environmental
Quality.

Very truly yours,

Edward C. Vest

Edward C. Vest
Environmental Impact Statement
Coordinator

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
Department of the Army
210 North 12th Street
St. Louis, Missouri 63101

Reference: LMSED-BR

Dear Mr. Niemi:

1 This is in reply to your letter of February 25, 1974, addressed to the Commission's Advisor on Environmental Quality, requesting comments of the Federal Power Commission on a draft environmental statement for Union Lake, Bourbeuse River, Missouri.

2 The Union Lake project was authorized by the Flood Control Act of 1938 and modified by the Flood Control Act of 1966 which incorporated the project into an overall plan for development of the Meramec River Basin.

3 These comments of the Federal Power Commission's Bureau of Power are made in accordance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality. Our principal concern with developments affecting land and water resources is the possible effect of such developments on bulk electric power facilities, including potential hydroelectric developments, and on natural gas pipeline facilities.

4 The Commission has previously considered the hydroelectric power potential of the Union Lake project. In its letter to the Chief of Engineers, dated May 27, 1966, reviewing the comprehensive plan for the development of the Meramec River Basin, the Commission concluded that there was no opportunity for economical hydroelectric power development at this project.

5 The draft environmental statement indicates that project construction will involve remedial measures to existing power lines, presumably relocation or protection. Such measures should be undertaken in such a manner as to minimize any disruptions of service.

6 The staff review indicates that construction of the Union Lake project would not affect any electric power or natural gas pipeline facilities under the jurisdiction of the Federal Power Commission. Also, the project would not appear to have any significant effect on the development of future supplies and transmission of electric power or natural gas.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL BUILDING, 911 WALNUT STREET
KANSAS CITY, MISSOURI 64106

REGION VII

March 4, 1974

IN REPLY REFER TO:

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

We have received the Draft Environmental Impact Statement prepared by your office for the Union Lake, Bourbeuse River, Missouri project.

Environmental reviews for projects in the eastern portion of Missouri are made by our St. Louis Area Office. We are forwarding your draft statement to Mr. Elmo Turner, Area Office Director, who will submit his comments directly to you.

Sincerely,

Charles B. Huyett
Charles B. Huyett
Assistant Regional Administrator
Community Planning and Management

cc:
Elmo Turner

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
210 NORTH 12TH. STREET, ST. LOUIS, MISSOURI 63101

REGION VII
REGIONAL OFFICE
KANSAS CITY, MISSOURI

AREA OFFICES
Kansas City, Kansas
Omaha, Nebraska
St. Louis, Missouri

April 22, 1974

IN REPLY REFER TO:
7.3PP

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Subject: Draft Environmental Impact Statement for Union Lake, Bourbeuse River, Missouri, rated February 1974

Reference is made to your letter of February 25, 1974 requesting comment on the Draft Environmental Statement for Union Lake, Bourbeuse River, Missouri. The letter and Draft Environmental Statement has been forwarded to this office for review and comment.

Our primary concern is that the environmental statement does not
include a detailed analysis of the additional reservoirs and basin
developments which are required to support this proposed project.
Collectively, the proposed major reservoirs in the Meramec River
Basin will have a dynamic environmental impact on the St. Louis
Metropolitan Area as well as the regional land use and transporta-
1 tion plans. Therefore, it is suggested that a cumulative compre-
hensive environmental statement for all proposed developments
within the basin should be prepared. Due to the energy shortage
and changing economic conditions, it is most difficult to intelli-
gently analyze and review a major river project proposal, especially
within a S.M.S.A., without evaluating all aspects of a river basin
development program.

We are also concerned about the increased rate of development in
this rural area if the project is approved. A recent field
reconnaissance of the site revealed increasing scattered develop-
ment activities. In addition, numerous real estate signs advertising
lots and home sites were observed. Unless a comprehensive plan is
2 prepared (for land outside the project area) which provides policies
and procedures for implementation, and which is based on land use
goals and objectives of the region and the county, then desired project
objectives probably will not be achieved, and the process of guiding
development adjacent to the largest Federal project in Franklin County
will produce unwanted effects and frustrations for everyone.

It should be noted that both land use controls and planning of
nonproject lands are local matters, governed by the citizens whose
interest they concern. Even if a comprehensive plan is developed
and adopted by the local legislative authorities, a major considera-
3 tion is that Franklin County and the incorporated communities have
all the essential tools and procedures to effectively implement the
plan. In theory, zoning ordinances and building codes are supposed
to implement plans, but experience reveals that, in practice, they
seldom do; other procedures are usually required.

It is suggested that existing and proposed county and municipal land
use plans, control proposals, and implementation procedures, be
jointly reviewed with the Corps, the East-West Gateway Coordinating
Council, and the Missouri Department of Community Affairs. This
could lead to a more uniform and comprehensive planning and develop-
ment process. Land use control proposals adjacent to the project
area should be based on carefully conceived objectives which include
input from the local residents, developers, and officials. These
4 goals have to be the heart of the comprehensive plan. Another factor
which must be emphasized is the importance of local and regional
citizen involvement in the land use planning and control process.
Citizen concern has been most evident at the local level throughout
the St. Louis Metropolitan Area, especially in the rural areas. In
many localities, they are demanding a slowdown in the growth process.
Initially, people are demanding that public officials conserve
natural resources and proctect the environment. The citizens must
be informed about the direction and substance of the project impact
(physically, socially, economic) and a channel for citizen input
into the planning process must also be provided.

The statement should further emphasize that during this past year,
land use proposals have been introduced by Congress and extensive
hearings were held. There is still extensive congressional review
and the land use issue is very much alive. Those jurisdictions who
ignore these emerging needs for a new system of land controls run
5 the risk of having decisions imposed upon them at a level higher than
their own. Therefore, the development and adoption of land use plans
and controls most appropriate to carry out the intent of the proposed
project and especially the enforcement of the application upon lands
in private ownership through the regulatory power of the local county
or municipality must be discussed and encouraged.

We appreciate the opportunity afforded us by the Corps of Engineers to review and comment upon their draft statement and look forward to receiving a copy of the final statement when it becomes available.

Sincerely,

Elmo Turner
Area Director

United States Department of the Interior

OFFICE OF THE SECRETARY

MISSOURI BASIN REGION
DENVER, COLORADO 80225

In Reply Refer To:
ER-74/284

June 18, 1974

Dear Mr. Niemi:

In response to your letter of February 25, 1974, we have reviewed the draft Environmental Impact Statement on Union Lake, Missouri. We offer these comments for your consideration.

General Comments

A thorough survey is necessary to adequately define the impact on
cultural resources as the draft statement does not contain an adequate
discussion. It acknowledges that two sites are under consideration for
nomination to the National Register of Historic Places, but it does not
reflect compliance with Section 106, P.L. 89-665 and Sections 1 (3) and
1 2 (a) of E.O. 11593. This is particularly essential in that these two
sites, Moser's Mill and the Koenig Site, have been referred to the
Secretary of Interior for determination of eligibility for nomination.
Until a complete survey and inventory of the project area is made, a
comprehensive plan of salvage cannot be developed.

We are pleased to see the reference to the 1962 "acquisition policy"
agreement between the Departments of Army and Interior. However, the
statement does not explain how this policy will be implemented with
respect either to the acquisition and/or subordination of mineral
2 interests. Nor does it indicate that before an easement can be taken
in lieu of fee title the lands must be examined by the Bureau of Sport
Fisheries and Wildlife and the Missouri Department of Conservation to
determine their significance for protection or enhancement of fish and
wildlife resources.

The statement does not consider the possibility of pollution from the
3 filled zinc-iron mines listed on page 60. If any of these mines would
be inundated, the statement should describe mitigating measures.

The need for recreational areas for the people of St. Louis is recog-
nized, but conditions have changed considerably since these reservoirs
4 were authorized. Alternatives are now available. Development of the
Great Rivers Recreation Area in the immediate vicinity of St. Louis
would help to satisfy this demand, save gasoline, and provide the
opportunity for many unable to travel as far as Union Lake.

The construction of Union Dam and Lake will have a deleterious impact on fish and wildlife resources. The Bureau of Sport Fisheries and Wildlife on January 28, 1964, provided a Preliminary Report on the effects of the water development plans for the Meramec River Basin. In this report, the Bureau stated that additional investigations would be conducted when more detailed plans became available. The Bureau, however, has not updated the 1964 Report.

5 We believe a 10-year lapse of time allows for considerable social, legislative, and biological changes to occur; therefore, the previous report is no longer valid. Until new studies are completed and loss compensation and enhancement features identified and evaluated, a true appraisal of the environmental impact cannot be made.

6 Based on the comments contained in this letter, the Department of the Interior believes that an adequate Union Lake Environmental Impact Statement must fully recognize and answer the specific comments contained in this letter. We believe that these issues warrant full coverage in the Impact Statement.

Specific Comments

7 Page One - [illegible]. Spillway discharges will be to a natural ravine that returns to Voss Creek, and then to the Bourbeuse River at Reiker Ford. Maximum spillway discharges are identified at [illegible] c.f.s.; however, no mention is made in the EIS of any impacts on Voss Creek or the ravine should it be necessary to use the spillway.

8 Page One - [illegible]. The Bureau of Sport Fisheries and Wildlife has no intention of constructing a fish hatchery below the dam and the statement should be corrected.

9 Page One - [illegible]. The statement indicates that flowage easements are to be acquired on [illegible] acres of land. To fulfill the joint land acquisition policy of the Departments of the Interior and Army, these lands would have to be examined by the Bureau of Sport Fisheries and Wildlife and Missouri Department of Conservation to determine the significance for protection or enhancement of fish and wildlife resources.

10 Page One - [illegible]. The statement should indicate whether the 21,993 acres to be acquired in fee would include mineral acquisition or subordination. If the "Joint Policy of the Departments of Interior and Army Relative to Project Lands" is followed, mineral interests would be acquired only where mineral development would interfere with primary project purposes.

11 Page One - 15. We wonder how the values for fish and wildlife benefits were determined. Our knowledge of the project indicates that it will have adverse effects on fish and wildlife habitat. Until these effects

are evaluated and mitigation measures for the losses incorporated into the development plan, we seriously question the benefits claimed for fish and wildlife in the statement.

It is impossible to assign negative benefits until the fish and wildlife
12 losses are evaluated, mitigation measures developed, and the amount of
uncompensated losses determined.

Page One - 15. "Once the lake is filled to the top of the joint-use
pool, releases will approximate inflows except during floods and
droughts." This expected downstream flows during flood conditions was
13 adequately described; however, some idea of what type of flows which
could be expected during time of drought should also be given. Also
needed is some idea of releases expected during initial filling of the
lake.

Page One - 16. "The control of floods by the impoundment will increase
the number of days on which float trips are possible, stabilize the
banks, and improve channel conditions." However, on page One - 15, it
14 states that flows at or above three-quarters bankfull will increase from
15 days per year without the dam to 40 days per year with the dam. Such
flows will cause bank cutting. We do not see how increasing these flows
will stabilize the banks and improve channel conditions.

Page One - 18. The net increase of 250,690 fisherman-days annually with
15 the project are contingent upon necessary loss compensation measures
being implemented. Reexamination of the area and identification of such
measures are necessary before this value can be established.

Page One - 19. Are flood control benefits for only presently existing
development in the flood plain, or do they include benefits assignable
to future development which will be encouraged by completion of the
projects? It is the view of the National Water Commission that the
major problem of reducing damages to existing development is overshadowed
by the need for keeping additional exposure to flood damages from devel-
16 oping. Flood damages are increasing in spite of billions of dollars
spent for protective works. In view of the statement made by the
St. Louis County planning commission on page eight - 22, it would appear
that some benefits assignable to flood control are for expected future
development encouraged by the project. Since construction will not pro-
vide for protection from Mississippi River backwater, future development
should be discouraged.

Page Two - 30. A more thorough discussion of the cave communities iden-
tified on page three - 16 is needed. It should be determined if the
17 Indiana Bat, identified as endangered on the official list of Endangered
Species, inhabits any of these caves. Would flooding of caves in the
flood pool or conservation pool make death traps of these caves?

18 Page Two - 43. Previous work in the area (Chapman et al, 1964, and Schneider and Geier 1971) has clearly documented the need for additional survey.

19 Page Three - 1. It is noted that the period of expected use of the flood pool - March, April, May and June - will be during peak nesting periods of upland game and spawning of warm water fishes in their river. Spawning in the 30 miles of river in the flood pool could be lost.

20 The last sentence in the paragraph on IRON ORE, page three - 10, should be changed to clearly indicate the effects of subordination or acquisition of the development of the known mineral deposits. In this sentence, it should be made clear that it is the <u>development</u> of these deposits that would be affected or unaffected. The statement should also consider the impact of the project on undiscovered mineral deposits that may exist and the search for such deposits.

21 Page Three - 32. It has not been determined that fish populations will benefit from increasing the period of time they will be subjected to 3/4 bankfill flows, therefore the statement that a maximum flow of water will be a stabilizing factor on the fish population needs some qualifications.

22 Page Three - 37. All three conversions could have significant impact on plant and animal communities if these conversions ultimately required a higher degree of flood protection which resulted in further alterations to the landscape. Some estimate of how many acres of each type of conversion is expected with completion of the project should be given. The comment by the St. Louis County Planning Commission on page eight - 22 leads us to believe that the Corps has developed this information.

23 Page Three - 40. In view of the weaknesses in the wildlife management plans implemented by the Corps of Engineers on existing reservoirs, we strongly recommend that all lands not needed for intensive recreation or project operation and maintenance be dedicated to fish and wildlife conservation purposes in accordance with a General Plan and be made available for management by the Missouri Department of Conservation.

24 Page Three - 45. A special study should be conducted to determine if any threatened species inhabit the caves. Reliance should not be placed on a lack of reported occurrences.

25 Page Three - 60. The final EIS on Meramec Park Lake identified [illegible] miles of floatable river in the Meramec Basin and 343 miles within the drainage area of Meramec Park and Union Reservoirs. Construction of the two projects will inundate 19.5% of the total floatable rivers in the entire basin, or 25% of the floatable rivers in the drainage of the two reservoirs. As indicated in the general comments, a study to identify the value of float streams in the Meramec Basin from a national, regional, and local standpoint should be completed.

26 Acquisition or subordination of mineral rights also would affect the wording in Part Seven, irreversible or irretrievable commitment of resources. Acquisition under the joint agreement implies that mineral development would not be permitted and thereby mineral loss to local and national use should be assessed as an irreversible or irretrievable commitment.

We appreciate the opportunity to provide our comments.

Sincerely yours,

William L. Rogers
Special Assistant to the Secretary

Mr. Jack A. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Advisory Council
On Historic Preservation

May 9, 1974

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District
Corps of Engineers
U.S. Department of the Army
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

1 This is in response to your request of February 25, 1974, for comments on the draft environmental statement for the proposed Union Lake, Bourbeuse River, Missouri. The Advisory Council has reviewed the statement and notes that the undertaking will affect the Koenig Site and Noser's Mill properties which may be eligible for inclusion in the National Register.

2 Pursuant to Section 2(b) of Executive Order 11593 "Protection and Enhancement of the Cultural Environment" of May 13, 1971, Federal agencies must, prior to the approval of the expenditure of any Federal funds on an undertaking or prior to the granting of any license, permit or other approval of the expenditure of any Federal funds on an undertaking or prior to the granting of any license, permit or other approval for an undertaking, afford the Advisory Council an opportunity to comment on the effect of the undertaking upon properties which may be eligible for inclusion in the National Register of Historic Places. For your convenience, a copy of the Council's "Procedures for the Protection of Historic and Cultural Properties" is enclosed.

3 Until the requirements of the Executive Order are met, the Council considers the draft environmental statement to be incomplete in its treatment of historical, archeological, architectural and cultural resources. To remedy this deficiency, the Council will provide substantive comments on the undertaking's effect on the previously mentioned property through the Section 106 process. Please contact Louis Wall of the Advisory Council staff (303-234-4946) to assist you in completing this process as expeditiously as possible.

Sincerely yours,

Ann Webster Smith

Ann Webster Smith
Director, Office of Compliance

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION SEVEN

April 1, 1974

IN REPLY REFER TO

07-00-ED

Mr. Jack P. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District
Corps of Engineers
210 North Twelfth Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Our review of your Draft Environmental Statement for Union Lake, Bourbeuse River, Missouri, developed the following comments. The review has been coordinated with our Secretarial Representative.

1. Part I, Paragraph II, AUTHORIZATION AND HISTORY OF THE PROJECT gives
the estimated cost of relocating Missouri State Highway 185 at a location and
elevation compatible with Union Lake requirements to be approximately $3,000,000.
It is not clear if this cost is directly related to the Union Lake Project over
1 and above the cost of the reconstruction of Highway 185 if Union Lake were not
developed. A clearer explanation of the project's impact upon Highway 185 will
be presented if the costs of reconstruction of Highway 185 as a result of the
project are compared to the costs of reconstruction without the project in the
Final Statement.

2. Route CC, a part of the Federal-aid System, crosses Big Creek within
the Flood Control Pool. Other local roads are also within the Flood Control
2 Pool, however, we could find no discussion on whether protection measures will
be taken to prevent damage or failure to these existing roadways due to fluc-
tuating water levels.

3. Part I, Paragraph IX A, RECREATION, indicates the project will support
an annual visitation of 1,878,000 recreationists within the first 3 years of
project life, with use expected to increase as facilities are added. Of this,
some half a million visitors are to be accommodated on Corps-constructed facil-
ities. Based upon the planning assumption that 80 percent of the visitors
3 come from sources within 100 miles of the project, there may be impacts upon
highways leading toward the project from population centers within the 100-mile
radius, primarily the St. Louis metropolitan area. When the projected recrea-
tional use generated by Union Lake is combined with the projected use to be
generated by the Meramec project to the south, it becomes evident that heavy

-more-

peak traffic flows will occur on I-44 and U.S. Highway 50 west of St. Louis. Those impacts should be discussed in detail.

4 4. Part I, Paragraph XII, PLANS OF OTHER FEDERAL AND STATE AGENCIES. We suggest the plans of the Missouri State Highway Department for Highway 185 be discussed in detail here. Presently, their plans are mentioned in various parts of the Statement with no full discussion in any one place. In addition, information concerning relocation assistance needed as a result of the highway reconstruction should be given.

We appreciate the opportunity to review and comment on this Draft Statement and look forward to receiving the Final.

Sincerely yours,

John B. Kemp
Regional Highway Administrator

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

April 15, 1974

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Reference: LMSED-BR

Dear Mr. Niemi:

The draft environmental impact statement for Union Lake, Bourbeuse River, Missouri, which accompanied your letter of February 25, 1974, has been reviewed and the following comments are offered for your consideration.

1 The environmental impact statement indicates that no active commercial fishery exists, but that populations of those species categorized as commercial, namely catfishes and freshwater drum, could increase in the impoundments created by project implementation.

2 A search of our geodetic control data publications indicates that construction of the Lake should not result in destruction or damage to any network monuments.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler
Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON, D.C. 20506

OFFICE OF ECONOMIC
OPPORTUNITY

August 22, 1973

MEMORANDUM TO HEADS OF ALL FEDERAL AGENCIES

SUBJECT: Meeting Requirements of National Environmental Policy Act of 1969 (NEPA)

The Office of Economic Opportunity is in the process of being reorganized. During this period of reorganization, the agency will not undertake any actions with regard to either Environmental Impact Statements or comments as to same, pursuant to the National Environmental Policy Act of 1969. It would be in keeping with the meaning and spirit of the NEPA if future activities were subjected to the Office of Management and Budget Circular A-95 clearinghouse procedures and submitted to interested and affected local community groups and organizations for their review and comments.

Arthur J. Reid, Jr.

Arthur J. Reid, Jr.
Director
Intergovernmental Relations

EXECUTIVE OFFICE
STATE OF MISSOURI
JEFFERSON CITY

CHRISTOPHER S. BOND
GOVERNOR

June 17, 1974

Colonel Thorwald Roger Peterson
District Engineer
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Peterson:

This is in response to your request for my review of and comments on the Union Lake Draft Environmental Impact Statement.

1 At my direction, the appropriate agencies of the state conducted a thorough and objective evaluation of the feasibility and effects of this project, utilizing the EIS and other sources of information. I conclude from this review that Union Lake as proposed would be of high quality for recreational purposes, provide significant opportunities for flatwater recreation and associated activities, create a source of water supply of potential value in future years to area communities, and provide a measure of flood control for the developed areas in the downstream reaches of the basin. Although there would be some limited adverse effects on the natural resources of the area, benefits of the project are significantly greater; therefore, the project is acceptable to the state.

2 We did, however, encounter several deficiencies in the EIS process which we hope will be overcome to provide more information toward the planning of the other Meramec Basin projects.

3 1. The loss of natural habitat could have a significant impact on wildlife. It is imperative that the Corps recognize the importance of providing suitable lands for the mitigation

Colonel Thorwald Roger Peterson
June 17, 1974
Page 2

of wildlife losses. The attached letter from Mr. Carl R. Noren,
3 Director of the Missouri Department of Conservation, discusses
this matter in greater detail.

2. It is recommended that present guidelines used in
determining the recreational use of proposed projects be
improved in the future so they yield more representative
values; this matter is discussed in greater detail in the
4 attached letter from Mr. James L. Wilson, Director of Missouri
State Park Board. The University of Missouri - Columbia
has designed and applied useful criteria in assessing the
recreation benefits of the proposed Pattonsburg project and
may be of service to you in future projects.

3. Information in the EIS regarding agricultural losses
should be more detailed and we hope the Corps will emphasize
5 the need for closer scrutiny of the values of permanent
loss of farmland in return for increased protection in other
areas. With regard to water supply, the Missouri Geological
Survey has concluded that more groundwater is available in
the upper reaches near Sullivan than the EIS indicates; I
6 understand that this conclusion is based on more recent
information than was available to you and that this data is
being forwarded to your office.

These dificiencies made it more difficult to determine
the true feasibility and effects of Union Lake. We could
not make a determination at this time of Pine Ford, I-38, and
7 Irondale since sufficient information has not been assem-
bled by your office. As studies progress on these remaining
three Meramec Basin projects, it is imperative that state
government be involved in all phases of the planning process.

Missouri has seven District-level Corps offices, each
working rather independently on projects in our state. We
recommend that the seven districts combine their efforts in
determining such essential state-wide impacts as the need
8 for outdoor recreation opportunities and the loss of pro-
ductive farmland and wildlife habitat. In this manner the
Corps can assist the state planning efforts considerably.
I welcome the initiative you have taken in working with the
other District Engineers toward this end.

Colonel Thorwald Roger Peterson
June 17, 1974
Page 3

9 Water resource planning in our state is of vital importance since decisions we make today will effect many future generations of Missourians. I endorse Union Lake and believe it will be very beneficial to our citizenry and be of high quality. The opportunity to review and comment on major proposed reservoirs is appreciated and I thank you for your close cooperation.

Sincerely yours,

Christopher S. Bond

GOVERNOR

CSB:mnc

Enclosures

MISSOURI DEPARTMENT OF CONSERVATION
2901 North Ten Mile Drive - Jefferson City, Missouri 65101
P. O. Box 180 - Telephone 314 751 4115
CARL R. NOREN, Director

June 6, 1974

Honorable Christopher S. Bond
Governor of Missouri
State Capitol Building
Jefferson City, Missouri 65101

Re: Meramec River Basin - Union Reservoir - Draft Environmental Impact Statement

Attention: Mr. Marvin Nodiff

Dear Governor Bond:

Several items of special concern to our Department were noted in reviewing the
Corps of Engineers' Draft Environmental Statement for Union Lake (February
10 1974). One is the proposed warm water hatchery facility downstream of the dam
and another the mitigation of terrestrial wildlife habitat losses. Detailed com-
ments on these and various other items are enumerated on the attached sheet.

Provision of water supply facilities capable of serving a warm water hatchery
was suggested as a desirable project addition in view of the proximity to metro-
11 politan St. Louis. Future needs for such a facility are not definitely known; how-
ever, with the water supply available, developing a hatchery to assist in meeting
future metropolitan area fishing needs would be greatly simplified.

Of greatest concern are the anticipated adverse project impacts on wildlife as
related to the project area terrestrial habitats. These losses have not been
quantified in terms of habitat units or values foregone. Contrary to the EIS
(Three-37.3. Line 5), techniques do exist for demonstrating impacts on wildlife
12 without and with a project. Personnel of the Bureau of Sport Fisheries and
Wildlife and Department of Conservation are prepared in 1974-75 to evaluate
the project and its influence area to document the situation. Such data would
be valuable for future reference.

The project as authorized does not provide for mitigating terrestrial habitat
losses. A general evaluation of anticipated project effects on wildlife was made
by our personnel. Numerous meetings were held with the federal Bureau of
Sport Fisheries and Wildlife and with the St. Louis Corps of Engineers District
personnel to discuss and negotiate ways to resolve the problem. General agree-
ment was reached on blocks of upper reservoir border lands that could be
developed and managed to partially offset terrestrial losses. Federal construc-
13 tion agency responsibilities for development as to location, amount and type have
not been established. Neither has the operation-maintenance responsibility been
settled. Since the Office of the Chief of Engineers has not yet approved the
recommendation of the St. Louis District for additional lands, we are at a loss
to know how to respond. It is definitely in the best interest of the State of
Missouri to have these matters with respect to wildlife as fully settled as are
the details on other project features.

We are pleased to offer these comments.

Sincerely,

CARL R. NOREN
DIRECTOR

cc: Mr. Terry Rehma
State Clearinghouse Coordinator
Department of Community Affairs

UNION RESERVOIR

DRAFT ENVIRONMENTAL STATEMENT

Miscellaneous Specific Comments

One-8-C.1 -
One-13-VI.A -
One-23-C -

14 Refer to warm water hatchery. It is good planning and wise to build to meet possible future needs. The Department of Conservation is not now committed to a time table for hatchery construction or even to ever constructing a hatchery.

One-11-B (Paragraph 1 and 2) -

15 Clearing of reservoir. Downed timber in some locations could be desirable for its fisheries values. A minimum clearing policy if followed would help achieve maximum reservoir values for fish and wildlife and also to some degree serve in reservoir zoning.

One-11-C (Paragraph 2) -
One-12 (Plate 4) -
One-14-VIII (Bottom Paragraph) and Table 3 -
One-18-E (Paragraph 3) -
Seven-1 (Paragraph 2)

16 Project land additions. Reference is made throughout the report to the proposed acquisition of an additional 4,200 acres in the upper reaches of the lake. The specific location(s) of the lands is not shown on the project maps. Is it definite that the land will be acquired? Does the 21,993 acres of fee and easement land include the additional lands to be acquired for fish and wildlife purposes? What will be offered under a General Plan?

One-15 (Paragraph 1) -

17 Acquisition Criteria. Experience on other projects indicates that exceptions to the 300' buffer strip criteria should be kept to the very minimum to prevent future encroachment on project lands and to maintain high aesthetic qualities.

One-16 (Paragraph 2) -
Three-56-1.a -

18 Recreation Areas. The Department of Conservation is not at this time committed to manage any recreation areas with facilities developed for high intensity use.

One-18-E (Line 7 and 8) -

19 Warm water discharge. More accurately stated, a warm water fishery will still be possible downstream. "This provision will insure preservation of the existing downstream fishery" is not necessarily true.

Three-40C (Paragraph 3)
Three-58 (Table 19)

20 How and when will the "detailed wildlife management plan" be developed? Will implementation, operation and maintenance cost be at project expense?

Three-40C.1.a -

21 Total habitat loss is the overriding factor for deer as well as for other species. Cropland represents only a portion of the picture.

Three-55 -

22 Since mosquitos are excellent fish food, leaving fish cover wherever possible through reduced timber clearing might further alleviate any anticipated problems.

MISSOURI STATE PARK BOARD
P.O. BOX 176 • 1204 JEFFERSON BLDG. • JEFFERSON CITY, MO. 65101 • 314/751-3332

June 14, 1974

Honorable Christopher S. Bond
Governor of Missouri
Executive Office
Capitol Building
Jefferson City, Missouri 65101

Dear Governor Bond:

In response to your request, we submit the following comments in regard to the Draft Environmental Statement for Union Lake as prepared by the St. Louis District Corps of Engineers.

During our review of the EIS and discussions with the Corps of Engineers, they indicated that the primary recreation market area of a Corps of Engineers' lake project is within approximately a 100 mile radius of the project.

In applying this guideline to projects similar to the proposed Union Lake we find that the following existing or proposed projects overlap the Union Lake (Meramec Basin) market area: Carlyle, Shelbyville, and Rend Lakes in Illinois, Lock and Dams 24, 25, and 26 in Missouri and Illinois, Cannon, Long Branch, Harry S. Truman, Stockton, Pomme de Terre, Table Rock, Clearwater, and Wappapello Lakes in Missouri, and Norfolk and Bull
23 Shoals Lakes in Missouri and Arkansas.

This indicates that the market area of the Meramec Basin projects are overlapped by fourteen other projects. Seven of these projects are shown to be competing for the St. Louis Metropolitan market area.

In order to determine the potential visitation to Union Lake and the other Meramec Basin projects it appears that it would be necessary to determine the recreation demand of the market areas for all competing projects and then deduct the existing supply. If this methodology were used it would more clearly reflect the needs that could be met by each project, making it easier to project attendance.

The EIS states the lake will "...increase the opportunity for recreation on the 32 miles of the Bourbeuse River below the dam and 60 miles on the Meramec River...."

24 The Corps of Engineers is acquiring land immediately below the dam that could be developed for access to the river. Additional facilities should be provided, as part of this project, to provide access to the lower reaches of the improved stretches of river.

25 The Corps of Engineers should complete a survey of project lands identifying potential sites that might qualify for nomination to the National Register of Historic Places. The final disposition of these sites should be discussed.

26 More consideration should be given to the discussion of site analysis in relation to the carrying capacity of recreational areas.

27 On Page Two-50, Montauk State Park should not be listed as being in the Meramec Basin.

28 Population projections should be given for the entire project market area, not just Franklin County.

29 As a result of this review it is my opinion that the State of Missouri should continue to support the Union Lake project.

Sincerely yours,

MISSOURI STATE PARK BOARD

James L. Wilson
Director of Parks

JLW:KO:ab

bcc: Mr. Marvin J. Nodiff
Mr. Ken Otke

MISSOURI STATE PARK BOARD

State Historical Survey and Planning Office • 908 University Avenue
Suite 215 • Columbia Professional Bldg • Columbia, Mo 65201 • 314 449 0725

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April 26, 1974

Col. Thorwald R. Peterson
District Engineer
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Col Peterson:

The State Historical Survey and Planning Office has reviewed the Draft Environmental Impact Statement for the Union Reservoir on behalf of Mr. James L. Wilson, Missouri's State Historic Preservation Officer. Although there are no sites currently listed on the National Register of Historic Places in the project area, two sites are under study as mentioned in the Statement. These are the Koenig Shelter and Noser's
1 Mill. These sites will be presented to the Missouri Advisory Council on Historic Preservation for their recommendations at their June meeting. Meanwhile, these sites have been submitted to the Secretary of the Interior for determination as to their worthiness under the provisions of Section 2(b) of Executive Order 11593. When such a determination is made, these sites will receive the full protection of Section 106 of the Historic Preservation Act of 1966.

The sections on the historical resources of the area are far from complete. A brief perusal of Caldwell's Historic Sites Catalogue and two interviews do not constitute an adequate survey of this area. A cursory survey, undertaken by two of our staff members in early April revealed many mid and late nineteenth century structures that appear
2 to meet the criteria for the National Register of Historic Places. With the exception of the Noser's Mill discussion, it becomes apparent that little or no field survey of the area has been conducted by a competent historian and/or architectural historian as required by Executive Order 11593. We highly recommend such a survey prior to preparation of the Final Environmental Statement.

Although an archaeological survey of the area has been made under the provisions of the Reservoir Salvage Act of 1960, it must be remembered
3 that such a survey does not necessarily fulfill the requirements of either the National Environmental Policy Act or Executive Order 11593. Shoreline sites affected by wave action and erosion, sites in the flood

pool elevations that will be affected by a fluctuating water table, and sites in the public access and recreation areas should be surveyed to supplement the past data and complete the prehistoric inventory of the area.

Thank you for allowing us to comment on this project. If we can be of further help, please do not hesitate to write or call.

Sincerely,

STATE HISTORICAL SURVEY AND PLANNING OFFICE

Susan B. Traub

(Mrs.) Susan B. Traub
Research Associate

SBT:bgg

MERAMEC BASIN ASSOCIATION

221A SOUTH KIRKWOOD ROAD • KIRKWOOD, MO. 63122

Phone 966-8550

April 15, 1974

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Re: Environmental Impact Statement - Union Lake

Dear Mr. Niemi:

Herewith is our comment on the Environmental Impact Statement for Union Lake.

The statement covers the subject and is well done. It reflects the
planning that has been done on the lake through the careful and compre-
hensive investigation, and the coordinated effort thereon, by local, state
1 and federal interests. Backed by the Basin-wide environmental study by
your office, and with the extensive coverage of subject matter in the state-
ment itself, it constitutes a proper expression under the law of the
various impacts that go with the project.

There is no doubt in the view of the Association that Union Lake is
2 the most suitable alternative for handling the needs of the people and
resources of the area, as provided for in the Basin plan.

3 The Meramec Basin Association continues its endorsement of this
project.

Sincerely,

James F. Gamble
President

JFG/nhr

MISSOURI SPELEOLOGICAL SURVEY Inc.

A NON-PROFIT AFFILIATION OF CAVING GROUPS

Please Address
Reply To

Thomas F. Cravens
Chairperson, Soc/Anthro Dept.
Meramec Community College
1333 Big Bend Blvd.
Kirkwood, Missouri 63122

April 1[illegible]th, 1974

Jack [illegible]. [illegible]
Chief Engineering Division
Department of the Army
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Sir:

I am writing this letter in response to your letter of February 25, 1974 in which you solicit the comments of the Missouri Speleological Survey on the <u>Draft Environmental Statement Union Lake Bourbeuse River Missouri.</u> The Missouri Speleological Survey has for the better part of the last two decades attempted to locate, record, explore, conserve and research the ecology of caves in the state of Missouri. As a result of our efforts in pursuant of the above mentioned activities, we have established certain informational guidelines which we consider essential for the development of an adequate understanding of the environment of a given cave. These guidelines are considered minimal and in no way represent the optimum coverage for a given cave. It is the feeling of the Missouri Speleological Survey (as clearly indicated to the United States Army Corps of Engineers in a communication from Missouri Speleological Survey on May 8, 1973 relating to the <u>revised and supplemented Draft Environmental Statement for Meramec Park Lake and Meramec Park River</u>) that any Environmental Impact Statement which seeks to conform to the intent and purpose of the National Environmental Policies Act of 1969, PL-190 should contain the following data on each and every cave within the area involved:

MISSOURI SPELEOLOGICAL SURVEY CAVE REPORT GUIDE LIST

1. Narrative description of the cave containing all significant aspects of the cave.
2. Geological report. This should indicate all important geological aspects of the cave, such as the formation in which the cave is developed, general developmental patterns, and specific geological aspects of importance in the cave.

3. Hydrological report. Description of the hydrology of the cave itself and particularly the relationship between the cave and the general hydrological aspects of the area in which it is found.
4. Biological report. A listing of all species of life found in the cave, including data concerning populations of various species, and habitat locations within the cave.
5. Cave map. It is considered essential for any adequate understanding of the cave to possess a relatively high quality map which allows for the geological, hydrological and biological reports above to be placed in the context of a specific cave and thereby allow for the development of an understanding of these three variables' relationship to one another.
6. Entry photographs and photographs of significant aspects of given caves.
7. Additional reports concerning such topics as archeological and paleontological aspects where necessary.

The Draft Environmental Statement Union Lake Bourbeuse River Missouri is unquestionably inadequate. It does not contain for any of the caves in the project area even one of the seven necessary reports referred to above. The Missouri Speleological Survey is somewhat dismayed over what can only be interpreted as a flagrant disregard for National Law. The Missouri Speleological
2 Survey would like to request that the United States Corps of Engineers seek to comply with the purpose and intent of the National Environmental Policies Act of 1969 and modify the current Draft Environmental Statement in such a way so as to provide an adequate understanding of the speleological environment of the area in question.

Sincerely yours,

Thomas F. Cravens
President,
Missouri Speleological Survey

TFC/bmk

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CITIZENS COMMITTEE TO SAVE THE MERAMEC, INC.

Box 88, Leasburg, Missouri 65535

Bob Thomas, President – Al "Bud" Dierking, V.P.

Emmett W. Schlueter
V. P. CCSM
R.R. #2 Box 161
Bourbon, Mo. 65441
April 5, 1974

Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Mo 63101

Re: Draft Environmental Statement Responce--Union Lake

Dear Sir:

Once again the Corps of Engineers has done a very admirable
job of compiling a literal wealth of figures and statistics. The
1 careful study of these volumes will, no doubt, bring a far greater
understanding of the Bourbeuse River system to a relatively few
people.

In depth this Environmental Statement, although quanitatively impressive, seems to be beating the same old drum for the same old reasons. Taken in the order of their economic importance we have the seven project purposes as follows:

Recreation

Recreation is at present a very important part of the activity
in the Meramec Basin which includes the Bourbeuse River System. The
only forms of recreation activities that would be enhanced by the
installation of impoundments are water skiing and power boating,
2 which according to the Outdoor Recreation Resources Review Commission
will comprise only 5% of future recreation demands. Activities such
as stream fishing, hunting, river boating and canoeing, nature study,
and the simple enjoyment of a rural setting in a natural environment,
will all be drastically diminished by the completion of the Union Dam.

All future recreation needs of the Basin can be easily met by
the strategic installation and maintainance of open space parks and
access points along the river. The requirements of the Metropolitan
St. Louis Area can far more adaquetly be served by a Lower Meramec
3 Recreation Area at just a fraction of the cost of the now proposed
Meramec Basin Plan. The adoption of such a plan would also serve
the purpose of flood control by negating the possibility of urban
encroachment on the flood plain.

4 The Statement assigns a questionably large figure to the recreation benefit to be derived from the Union Lake. It is not at all clear whether the Corps has assigned dollar values to the recreational activities lost to the project or whether this figure is considered in the cost column.

Flood Control

5 Man has been practicing structural flood control for 4000 years with approximately the same degree of failure each and every year. We spend ever increasing millions and even billions on flood control projects and our flood losses have risen more than tenfold since the 1930's. It is high time we stop trying to regulate the apparently uncontrolable flood waters and concentrate on the folly of placing development in their path.

6 This Statement indicates that 8,574 acres of agricultural land will be irretrievely committed to the project. I found no indication of the value of the product from this land or that the particular value is, as well, a cost of the project. This should be incorporated.

Regulation of Stream Flow (Water Quality)

7 The arbitrary practice of increasing stream flows to abate pollution during low flow periods is clearly contrary to directives expressed in the Federal Water Pollution Control Act, and requires no further comment.

Water Supply

8 The Missouri Geological Survey and Water Resources states that the ground water supply in the Meramec Basin is adaquate to meet all foreseeable needs. The Corps has again used questionably large population and demand figures in projecting future water needs in the Lower Basin. These requirements could yet be more adaquately met with water from the Missouri-Mississippi System, one of the mightiest river systems on Earth.

9. It is far more economical to utilize ground water supplies which require no elaborate purification. The cost of purifying surface waters in relation to drilling wells is tremendous.

10 The Meramec Basin is blessed with one of the highest quality ground water supplies in the Nation. The completion of proposed Corps of Engineers projects would place this resource under the threat of irrevocable contamination by leakage of surface waters into the ground water supply. We have no assurance that such a catastrophy would not occur. The Draft EIS states, "Drilled wells within the

Water Supply (cont.)

lake and project boundaries would be sealed or plugged in a manner to prevent pollution of ground water." Our water supply is perhaps our greatest gift from nature. The possibility of its contamination is in itself enough reason to abandon the Union Lake and the entire Meramec Basin Plan.

Fish and Wildlife Conservation

Webster defines the word conservation thusly:
(1) a conserving; protection from loss, waste, etc.
(2) the official care and protection of forests, rivers,
11 etc.
We suggest the word, conservation, be deleted from this heading as the project does not involve itself with conserving numbers or species of fish, wildlife, or vegetation.

A net increase of 250,690 annual fisherman days is claimed by the project, including 10,320 days on the downstream reaches. We
12 wonder if this figure is also included in the 18,000 days claimed for the downstream reaches of the Meramec Park Dam, and whether proper account was taken of the fishing activity now existing without the project.

The Missouri Department of Conservation has agreed to build only a fish hatchery below Meramec Park Dam. We've seen no evidence to indicate funding or authorization for similiar development at
13 other sites is available. It seems the Corps is trying to sell this question on "could be" rather than "will be". A similiar situation exists in the coordination with the Missouri State Parks Board with regard to state participation in recreation areas near the lake.

The entire fish and wildlife benefit could be accomplished
14 far more realistically and economically through other non-structural means, thereby holding true to the meaning of the term "conservation".

Area Development

The benefits of local economic development are another myth aimed at selling the project on "could be". The logic involved in assuming the labor force utilized in construction of the project would otherwise be unemployed is not evident. It is also pertenent
15 that all Corps projects that we have the particular information on were built by non-local contractors, usually from out-of-state. A recent example is the award of contract for construction of the access road and Administration Building at proposed Meramec Park Lake. This Contract went to a company from Nebraska.

Draft Environmental Statement Responce--Union Lake April 5, 1974

Area Development (cont.)

The other more publicised economic benefit of a tourist economy
seems to be, at best, superficial. Ultimately, local governmently
agencies would be required to provide all municipal services to this
16 economy without sufficient taxation and revenue returns. Our original
and now permanent economy would be replaced or controlled by one of
non-local conglomerate type investments. This type of activity brings
only a relatively few menial wages into the local community and the
bulk of the revenues pass through and out of the area.

Navigation

House Document #686 states that maximum development of reser-
voirs in the Meramec Basin would amount to a reduction in the Mississ-
17 ippi flood stage of less than one tenth of one foot on the Cairo gage.
In view of the insignificant contribution the Basin makes to the
Mississippi System, any benefit to navigation seems to be rather
marginal.

Summary

The Union Lake Project and Meramec Basin Plan are based on
antiquated needs and trumped-up requirements. All seven project
18 purposes can be either accomplished through other more acceptable
means, or are not valid.

The project is a vital link in the proposed Basin Plan. The
"Plan" and the "Projects" are mutually dependent upon each other.
19 This statement is incomplete as it deals only with the Bourbeuse
Project and not the over-all Basin Plan.

We realize that The Corps of Engineers probably has a very
20 real and worthwhile role in our present day economy. We suggest
they relinquish all activity in the Meramec Basin and get at these
other more important tasks.

We appreciate the opportunity to respond to this statement.

Sincerely Yours,

Robert J. Thomas

Robert J. Thomas
Pres. CCSM

Sincerely Yours,

Emmett W. Schlueter

Emmett W. Schlueter
V. P. CCSM

Missouri Chapter
of the
American Fisheries Society

CHARTERED MARCH 10, 1964

March 18, 1974
Route 1, Box 208
Lohman, Missouri 65053

Col. Thorwald R. Peterson, District Engineer
U. S. Army Engineer District, St. Louis
Corps of Engineers
210 North 12th Blvd.
St. Louis, Missouri 63101

Dear Colonel Peterson:

We have received for review the Draft Environmental Statement for Union Lake, Bourbeuse River, Missouri. We appreciate the opportunity to comment and will forward our comments to you by April 15, 1974.

Please address future correspondence involving the Missouri Chapter, American Fisheries Society, to me at the above Lohman address.

Thank you.

Sincerely,

Lee C. Redmond
Secretary-Treasurer

LCR:cs

cc: Mr. Niemi
Dr. Rosebery
Mr. Funk

SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

PUBLISHER OF THE JOURNAL OF HERPETOLOGY, FACSIMILE REPRINTS IN HERPETOLOGY,
AND THE CATALOGUE OF AMERICAN AMPHIBIANS AND REPTILES

5 April 1974

Jack R. Niemi
Chief, Engineering Division
Dept. of the Army
St. Louis District, Corps of Engineers
210 North 12th St.
St. Louis, Missouri 63101

Dear Mr. Niemi,

The following letter concerns the Draft Environmental Statement - Union Lake - Bourbeuse River, Missouri.

On page three - 36 of this statement under (2) (a) amphibians is the statement that, "All of the species that occur in the project area are expected to continue existence in that area." There is every probability that this statement is incorrect! The primitive giant salamander, Cryptobranchus alleganiensis (Hellbender) is a resident of the Bourbeuse River (Nickerson & Mays, 1973b). Its populations are rapidly declining throughout its range and it is a valuable ($15 - $35 live) economic species (Nickerson & Mays, 1973b). It is known that populations "die-off" when reservoirs are constructed (Gentry, 1955). The reasons for death are now established! Although they have lungs, probably hydrostatic structures, their respiration is primarily cutaneous (Guimond & Hutchison, 1973). Their epidermis is somewhat thick and only the lateral folds are highly cutaneous (Noble, 1925). The hemoglobins have a low oxygen holding capacity and Missouri populations are biochemically and physiologically unique in having a single hemoglobin which has no Bohr effect (Taketa & Nickerson, 1973a; 1973b). This may add to the actual commercial scientific values of Missouri populations! A great number of researchers are currently studying these (Nickerson & Mays, 1973b). Cryptobranchus can withstand higher temperatures than many suspect (Hutchison et al., 1973). However, they can do so only by behavioral adaptations, with great energy expense ("rocking"), and only then if the water is reasonably

well oxygenated. In Southern Missouri Cryptobranchus move to riffles when water temperatures reach 70-72° F. They actually move from highly oxygenated still water to highly oxygenated moving water (Nickerson & Mays, 1973a; 1973b). A dam would destroy this habitat and Cryptobranchus populations. In one Missouri river (North Fork of the White River), Cryptobranchus populations may reach a density of one hellbender/8-10 sq. meters.
2 From a strictly economic viewpoint this could mean, $15-35/8-10 sq. meters in commercial retail value. Even a preserved specimen, with no data, brought $4 in 1969 and more today (Nickerson & Mays, 1973a; 1973b).

Literature Cited

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Sincerely yours,

Max Allen Nickerson, PhD
Head - Vertebrate Division
Milwaukee Public Museum
and
Research Associate
University of Wisconsin-Milwaukee

MAN:smp

partment of Life Sciences SOUTHWEST MISSOURI STATE UNIVERSITY SPRINGFIELD MISSOURI 65802 (417) 831 15

16 April 1974

Jack R. Niemi, Chief, Engineering Division
Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Re: Draft Environmental State, Union Lake

Because of limited time I will only comment on that part of the draft environmental impact statement that I am most familiar with, namely the botanical discussions.

1. I am extremely skeptical of the data provided on the vegetation within the
proposed lake. The data is very general and inaccurate. For example, the flora
of the Meramec basin listed in Table 18 (not 21 as referred to on page B-1) is
1 inaccurate. Taking just the first page alone there are more than a dozen species
that are not known from the area of the lake or even the Meramec River Basin. I
suspect that the compiler never set foot in the field. It appears that it was
compiled from Steyermark's flora of Missouri. It in <u>no way</u> represents what is
actually known to be present. The site data for forest composition is also sus-
2 pect. No reliable field data is cited and no indication of the extent of each
type of forest site is indicated. Without spending an inordinate amount of my
time I cannot begin to list all of the inaccuracies I have noted on botanical
3 data alone. If the rest of the report has been prepared as carelessly, then heaven
help the people who must use this report for making an evaluation of this project.

2. I do not find any meaningful analysis of the loss of agricultural land in
the area. The U. S. can ill afford to lose much more agricultural land. How
much agricultural land are we sacrificing to "protect" downstream bottomland
4 from flooding. Nor is the argument, put forth in several places in this report,
that the area might be damaged by urban development if not controlled very con-
vincing. The answer to this problem should be better land use policy, not
flooding it.

Paul L. Redfearn, Jr.
Professor of Life Sciences

PLR:eas

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TECHNICAL SERVICES DEPARTMENT

MRS DORALOUISE B BREWER
Supervisor, Technical Services

March 5, 1974

Mr. Jack R. Niemi,
Chief, Engineering Division
Dept. of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis,Missouri 63101

Dear Mr. Niemi:

We wish to acknowledge the receipt of your gift of

(3) sets DRAFT ENVIRONMENTAL STATEMENT FOR UNION LAKE, BOURBEUSE RIVER, MISSOURI, 2 vols.

Please accept our sincere thanks.

Yours very truly,

Doralouise B Brewer

(Mrs.) Doralouise B. Brewer
Supervisor, Technical Services

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